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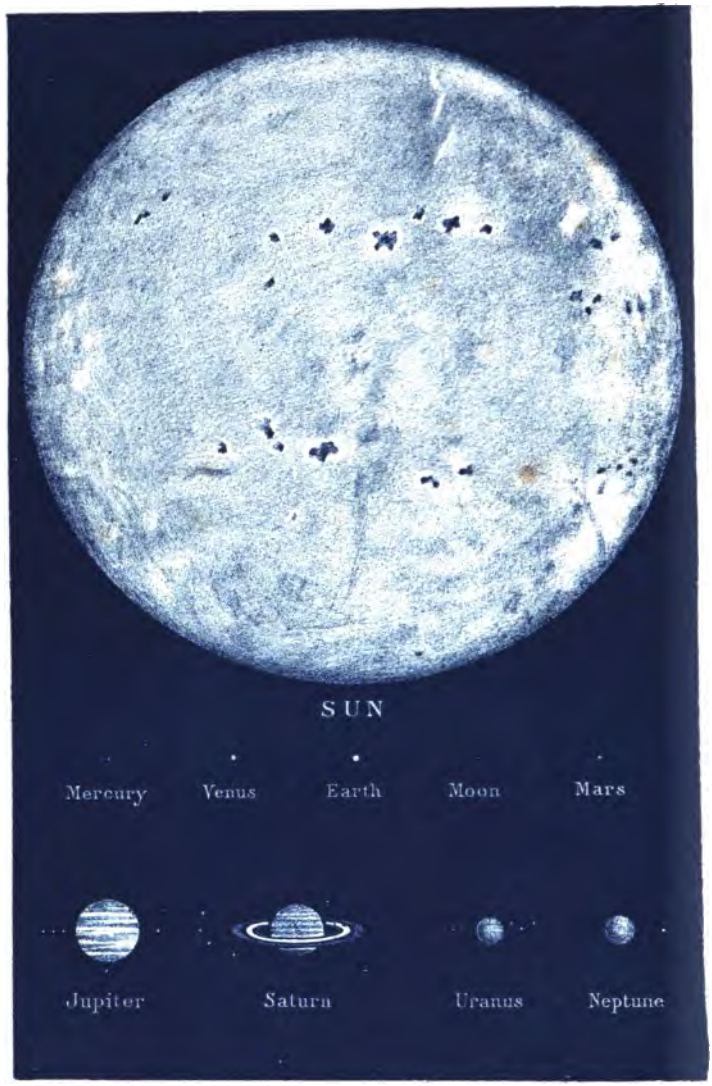

THE SOLAR SYSTEM—COMPARATIVE SIZES.

MORE WORLDS THAN ONE.

THE CREED OF THE PHILOSOPHER AND THE HOPE OF THE CHRISTIAN.

BY

SIR DAVID BREWSTER.

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PREFACE.

HAVING been requested by the Editor of the *North British Review* to give an account of a work entitled *Of a Plurality of Worlds, an Essay*, I undertook the task, in the belief that it contained sentiments similar to my own, and that I should have the gratification of illustrating and recommending a doctrine which had long been the Creed of the Philosopher and the Hope of the Christian. I was surprised, however, to find that, under a title tending to mislead the public, the author had made an elaborate attack upon opinions consecrated, as I had thought, by Reason and Revelation; and had, in conducting his argument, not only adopted the *Nebular Hypothesis*, so univer-

sally condemned as a dangerous speculation, but had taken a view of the condition of the Solar System, calculated to disparage the science of Astronomy, and to throw a doubt over the noblest of its truths.

Under ordinary circumstances I should have contented myself with such an analysis and criticism of the work as could be given within the narrow limits of a Review; but while the boldness of the author's speculations, and the ingenuity with which they were maintained, required a more elaborate examination of them, the new views which presented themselves to me during the study of the subject, demanded a copious detail of facts which could be given only in a separate Treatise. I have, therefore, devoted the principal part of the volume to a statement of the arguments in favour of a Plurality of Worlds, and have endeavoured, in the subsequent chapters, to answer the various objections urged against it by the author of the

Essay, and to examine the grounds upon which he has attempted to establish the extraordinary doctrines that the Earth is "the oasis in the *desert* of our system,"—"the largest solid opaque globe in it," and "really the largest planetary body in the Solar System,—its domestic hearth, and the only world in the Universe!"

D. BREWSTER.

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T. J. J. SEE
MARE ISLAND, CALIF.

MORE WORLDS THAN ONE.

INTRODUCTION.

THERE is no subject within the whole range of knowledge so universally interesting as that of a Plurality of Worlds. It commands the sympathies, and appeals to the judgment of men of all nations, of all creeds, and of all times; and no sooner do we comprehend the few simple facts on which it rests, than the mind rushes instinctively to embrace it. Before the great truths of Astronomy were demonstrated—before the dimensions and motions of the planets were ascertained, and the fixed stars placed at inconceivable distances from the system to which we belong, philosophers and poets descried in the celestial spheres the abodes of the blest; but it was not till the form and size and motions of the earth were known, and till the condition of the other planets was found to be the same, that analogy compelled us to believe that these planets must be inhabited like our own.

Although this opinion was maintained incidentally by various writers both on astronomy and natural religion, yet M. Fontenelle, Secretary to the Academy of Sciences in Paris, was the first individual who wrote a treatise expressly on the subject. It was published in 1686, the year before Sir Isaac Newton gave his immortal work, the *Principia*, to the world, and was entitled *Conversations on the Plurality of Worlds*. It consisted of five chapters with the following titles:—

1. The earth is a planet which turns round its own axis and also round the sun.

2. The Moon is a habitable world.

3. Particulars concerning the world in the Moon, and that the other planets are also inhabited.

4. Particulars of the worlds of Venus, Mercury, Mars, Jupiter, and Saturn.

5. The Fixed Stars are as many Suns, each of which illuminates a world.

In another edition of the work published in 1719, Fontenelle added a sixth chapter, entitled,

6. New thoughts which confirm those in the preceding conversations. The latest discoveries which have been made in the heavens.

This singular work, written by a man of great genius, and with a sufficient knowledge of astro-

nomy, excited a high degree of interest, both from the nature of the subject and the vivacity and humour with which it was written. The conversations are carried on with the Marchioness of G——, with whom the author is supposed to be residing. The lady is, of course, distinguished by youth, beauty, and talent, and the share which she takes in the dialogue is not less interesting than the more scientific part assumed by the philosopher.

The *Plurality of Worlds*, as the work was called, was read with unexampled avidity, and was speedily circulated through every part of Europe. It was translated into all the languages of the Continent, and was honoured by annotations from the pen of the celebrated astronomer La Lande, and of M. Gottsched, one of its German editors. No fewer than *three* English translations of it were published, and one of these, we believe the first, had run through *six* editions so early as the year 1737. Wherever it was read it was admired, and though *one hundred and sixty-seven years* have elapsed since its publication, we have not been able to learn that any attempt has been made, during that long period, either to ridicule or controvert the fascinating doctrines which it taught.

A few years after the publication of Fontenelle's

work, the celebrated philosopher Christian Huygens, the contemporary of Newton, and the discoverer of the ring and one of the satellites of Saturn, composed a work on the Plurality of Worlds, under the title of the *Theory of the Universe, or Conjectures concerning the Celestial Bodies and their Inhabitants.*[1] This interesting treatise, as large as that of Fontenelle, was translated into English, and went through at least two editions.[2] It was written at the age of sixty-seven, a short time before the author's death; and so great was the interest which he felt in its publication, that he earnestly besought his brother to carry his wishes into effect. He mentions the great pleasure he had derived from the composition of it, and from the communication of his views to his friends. About to enter the world of the future, the philosopher who had added a new planet to our system, and discovered the most magnificent and incomprehensible of its structures,

[1] *Cosmotheoros*, sive de Terris Celestibus, earumque ornatu, conjecturæ, ad Constantinum Hugenium Fratrem, Gulielmo iii. Magnæ Britanniæ Regi a Secretis. Hugenii *Opera*, tom. ii. pp. 645-722.

[2] The Celestial Worlds Discovered, or Conjectures concerning the Inhabitants, Plants, and Productions of the Worlds in the Planets. The second edition, corrected and enlarged. London, 1722. The first edition seems to have been published in 1698. Two French editions of the Cosmotheoros were published, one in Paris, in 1702, the other at Amsterdam, in 1718.

looked forward with a peculiar interest to a solution of the mysteries which it had been the business and the happiness of his life to contemplate. He was anxious that his fellow-men should derive the same pleasure that he did, from viewing the planets and the stars as the seats of intellectual life, and he left them his Theory of the Universe—a legacy worthy of his name.

The *Cosmotheoros* is a work essentially different from that of Fontenelle. It is didactic and dispassionate, deducing by analogical reasoning a variety of views respecting the plants and animals in the planets, and the general nature and condition of their inhabitants. The work is to some extent a popular Treatise on Astronomy, and contains all that was at that time known respecting the primary and secondary planets of the solar system.

We are not acquainted with any other work written expressly on the subject of a Plurality of Worlds, but the doctrine was maintained by almost all the distinguished astronomers and writers who have flourished since the true figure of the earth was determined. Giordano Bruno of Nola,[1] Kepler and Tycho believed in it; and Cardinal Cusa and Bruno, before the discovery of binary systems

[1] In his work entitled *Universo e Mondi innumerabili*.

among the stars, believed also that the stars were inhabited. Sir Isaac Newton likewise adopted it, and Dr. Bentley, Master of Trinity College, Cambridge, in his eighth sermon on the Confutation of Atheism from the origin and frame of the world,[1] has ably maintained the same doctrine. In our own day we may number among its supporters the distinguished names of the Marquis De Laplace, Sir William and Sir John Herschel, Dr. Chalmers, Isaac Taylor, and M. Arago.

After the publication of Dr. Chalmers's *Astronomical Discourses*, in which the doctrine of a Plurality of Worlds was maintained with much eloquence and force of argument, an attempt to reply to it was made by a Mr. Alexander Maxwell, a London publisher, in a work which, though entitled *Plurality of Worlds*, contains only one chapter on the subject. This volume, a second edition of which was published in 1820, is written by a person who does not believe in the grand truths of Astronomy, and who regards the Newtonian philosophy as containing principles "which lie at the foundation of all atheistical systems," and which are not only absurd

[1] This sermon was written from the information given him by Sir Isaac Newton in his four celebrated letters addressed to Dr. Bentley.

but dangerous, " instilling a destructive poison into the human heart !"

Under these circumstances the scientific world has been greatly surprised at the appearance of a work entitled *Of the Plurality of Worlds*, the object of which, like that of Maxwell, is to prove that our earth is the only inhabited world in the universe, while its direct tendency is to ridicule and bring into contempt the grand discoveries in sidereal astronomy by which the last century has been distinguished. Although it is not probable that a work of this kind, however ably it is written, and however ingenious be the reasoning by which views so novel and extraordinary are maintained, will influence opinions long and deeply cherished, we have thought it necessary, in support of astronomical truth, as well as of the lessons which it teaches, to defend the doctrine of a Plurality of Worlds by the aid of modern discoveries, and to analyze and refute the objections which have been made to it in the work to which we have referred.

CHAPTER I.

RELIGIOUS ASPECT OF THE QUESTION.

BEFORE Christianity shed its light upon the world, the philosopher who had no other guide but reason, looked beyond the grave for a resting-place from his labours, as well as for a solution of the mysteries which perplexed him. Minds, too, of an inferior order, destined for immortality, and conscious of their destination, instinctively pried into the future, cherishing visions of another world with all the fervour of domestic affection, and with all the curiosity which the study of nature inspires. Interesting as has been the past history of our race,—engrossing as must ever be the present,—the future, more exciting still, mingles itself with every thought and sentiment, and casts its beams of hope, or its shadows of fear, over the stage both of active and contemplative life. In youth we scarcely descry it in the distance. To the stripling and the man it

appears and disappears like a variable star, shewing in painful succession its spots of light and of shade. In age it looms gigantic to the eye, full of chastened hope and glorious anticipation; and at the hour of transition when the outward eye is dim, the image of the future is the last picture which is effaced from the retina of the mind.

But however universal has been the anticipation of the future, and however powerful its influence, Reason did not venture to give a form and locality to its conceptions; and the imagination, even with its loosest reins, failed in the attempt. Before the birth of Astronomy, indeed, when our knowledge of space terminated with the ocean or the mountain range that bounded our view, the philosopher placed his elysium in the sky; and even when revelation had unveiled the house of many mansions, the Christian sage descried his future home in the new heavens and in the new earth of his creed. Thus vaguely shadowed forth,—thus seen as through a glass darkly, the future even of the Christian, though a reality to his faith, was but a dream to his reason. In vain did he inquire what this future was to be in its physical relations,—in what region of space it was to be spent,—what duties and pursuits were to occupy it,—and what intellectual and

spiritual gifts were to be his portion. But when Science taught him the past history of our earth, its form, and size, and motions,—when Astronomy surveyed the solar system, and measured its planets, and pronounced the earth to be but a tiny sphere, and to have no place of distinction among its gigantic compeers, — and when the Telescope established new systems of worlds far beyond the boundaries of our own, the future of the sage claimed a place throughout the universe, and inspired him with an interest in worlds, and systems of worlds,—in space without limits, as well as in life without end. On eagles' wings he soared in imagination to the zenith, and sped his way to the horizon of space, without reaching its ever-retiring bourne; and in the infinity of worlds, and amid the infinity of life, which his reason suggested, he descried the home and the companions of the future.

That these views are in accordance with the demonstrated truths of astronomy, and deducible from them by analogies which guide us in the ordinary business of life, it will be the object of this Essay to shew. But before entering upon the astronomical and geological details which will thus demand our attention, some preliminary observations are necessary to prepare our minds for the unfet-

tered discussion of a subject which ignorance and bigotry still surround with many prejudices.

In advocating a plurality of worlds, we are fortunately in a more favoured position than the geologist, whose researches into the ancient history of the earth stood in apparent opposition to the declarations of Scripture. Neither in the Old nor in the New Testament is there a single expression incompatible with the great truth, that there are other worlds than our own which are the seats of life and intelligence. Many passages of Scripture, on the contrary, are favourable to the doctrine, and there are some, we think, which are inexplicable, without admitting it to be true. The beautiful text,[1] for example, in which the Psalmist expresses his surprise that the Being who fashioned the heavens and ordained the moon and the stars, should be mindful of so insignificant a being as man, is, we think, a positive argument for a plurality of worlds. We cannot concur in the idea of Dr. Chalmers, that a person wholly ignorant of the science of astronomy, and, consequently, to whom all the stars and planets appear but specks of light in the sky, not more

[1] "When I consider thy heavens, the work of thy fingers, the moon and the stars, which thou hast ordained; what is man, that thou art mindful of him? and the son of man, that thou visitest him?"—PSALM viii. 3, 4.

important than the *ignis fatuus* upon a marshy field, could express the surprise and deep emotion of the Hebrew poet. Inspiration, no doubt, revealed to him the magnitude, the distances, and the final cause of the glorious spheres which fixed his admiration; and, when impressed with these truths, two portions of creation were presented to his mind in the strongest contrast,—Man in his comparative insignificance, and the Heavens,—the Moon and the Stars, in their absolute grandeur. He whom God made a little lower than the angels, whom He crowned with glory and with honour, and for whose redemption He sent His only Son to suffer and to die, could not, in the Psalmist's estimation, be an object of insignificance, and measured, therefore, by his high estimate of man, his idea of the heavens, the moon, and the stars must have been of the most transcendent kind. Had he been ignorant of astronomy, he never could have given utterance to the sentiment in the text. Man, made after God's image, was a nobler creation than twinkling sparks in the sky, or than the larger and more useful lamp of the moon. The Psalmist must, therefore, have written under the impression either that the planets and stars were worlds without life, or worlds inhabited by rational and immortal beings. If he

regarded them as unoccupied, we cannot see any reason for surprise that God should be mindful of His noblest work, because innumerable masses of matter existed in the universe, performing, for no intelligible purpose, their solitary rounds. If they were thus made for the benefit and contemplation of man, unseen by any mortal eye but his, then should the Psalmist have expressed his wonder, not at the littleness, but at the greatness of the being for whose use such magnificent worlds had been called into existence. But if the poet viewed these worlds, as he doubtless did, as teeming with life physical and intellectual, as globes which may have required long periods of time for their preparation, exhibiting new forms of being, new powers of mind, new conditions in the past, and new glories in the future, we can then understand why he marvelled at the care of God for creatures so *comparatively* insignificant as man.

It is evident, from the text we have been considering, and from other passages of Scripture, that the word *Heavens*, so distinctly separated from the moon and the stars, represents a material creation, the work of God's fingers, and not a celestial space in which spiritual beings may be supposed to dwell; and hence we are entitled to attach the same mean-

ing to the term wherever it occurs, unless the context forbids such an application of it. The writers, both in the Old and New Testament, speak of the heavens as a separate material creation from the earth, and there are passages which seem very clearly to indicate that they were regarded as the seat of life. When Isaiah speaks of the heavens being *spread out as a tent to dwell in*,[1] when Job tells us that God, who *spread out the heavens, made Arcturus, Orion and Pleiades*, and the *chambers* of the south,[2] and when Amos speaks of Him who buildeth His stories in the heavens,[3] (His house of *many mansions*,) they use terms which clearly indicate that the celestial spheres are the seat of life. In the book of Genesis, too, God is said to have finished the heavens and the earth, and *all the host of them*.[4] Nehemiah declares that God made the *heaven, the heaven of heavens, and all their host*, the earth and all things that are therein, and that *the host of heaven worship Him*.[5] The Psalmist speaks of *all the host of the heavens as made by the breath of God's mouth*,[6] (the process by which He gave life to Adam;) and Isaiah furnishes us with a striking passage, in which the occupants of the earth and of the heavens are

[1] Isaiah xlv. 22. [2] Job ix. 8, 9. [3] Amos ix. 6.
[4] Gen. ii. 1. [5] Neh. ix. 6. [6] Psalm xxxiii. 6.

separately described. "I have made the earth, and created man upon it: I, even my hands, have stretched out the heavens, and all *their host have I commanded.*"[1] But in addition to these obvious references to life and things pertaining to life, we find in Isaiah the following remarkable passage, "For thus saith the Lord, that created the heavens, God himself that formed the earth and made it; he hath established it, *he created it* NOT IN VAIN, *he formed it* TO BE INHABITED."[2] Here we have a distinct declaration from the inspired prophet, that the *earth would have been created* IN VAIN *if it had not been formed to be inhabited;* and hence we draw the conclusion, that as the Creator cannot be supposed to have made the worlds of our system, and those in the sidereal universe in vain, they must have been formed *to be inhabited.*

In the New Testament we find passages not only in perfect harmony with the doctrine of a plurality of worlds, but which cannot be well explained without admitting it to be true. When St. John tells us that the *Worlds* were made by the word of God,[3] and St. Paul, that by our Saviour, the heir of all things, were made the *worlds*,[4] we cannot suppose

[1] Isaiah xlv. 12.
[2] Isaiah xlv. 18.
[3] John i. 3.
[4] Hebrews i. 3.

that they mean Globes of matter revolving without inhabitants, or without any preparation for receiving them. Our Saviour is described as having made *All things*, and God is spoken of as purposing to "gather together in one *all things* in Christ *which are in the Heavens, and which are on Earth.*"[1] The creations thus described, under the name of *all things*, are clearly *creations in the heavens, or above them*, for Paul tells us that Christ "ascended up *far above all heavens*, that he might fill *all things.*"[2] In another place the Apostle speaks of the "mystery hid in God, who created *all things* by Jesus Christ; to the intent that now, unto the principalities and powers in heavenly places, might be known by the church the manifold wisdom of God."[3] When our Saviour speaks of the sheepfold of which He is the door, and of the sheep who follow Him and know His voice, and for whom He was to lay down His life, He adds, "and *other sheep I have which are not of this fold:* them also I must bring, and they shall hear my voice; and there shall be *one fold*, and one Shepherd."[4]

These views, as deduced from Scripture, receive much support from considerations of a very different

[1] Ephesians i. 9, 10.
[2] Ephesians iv. 10.
[3] Ephesians iii. 9, 11.
[4] John x. 16.

nature. Man in his future state of existence is to consist, as at present, of a spiritual nature residing in a corporeal frame. He must live therefore upon a material planet, subject to all the laws of matter, and performing functions for which a material body is indispensable. We must consequently find, for the race of Adam, if not for races that may have preceded him, a material home upon which they may reside, or from which they may travel by means unknown to us, to other localities in the universe.[1] At the present hour the inhabitants of the earth are nearly a *thousand millions;* and by whatever process we may compute the numbers that have existed before the

[1] "It seems to accord best with the goodness of God, and with the manner in which the universe is made, to suppose that every portion of it may be visited, and become successively the abode of the redeemed; that they may pass from world to world, and survey the wonders and the works of God as they are displayed in different worlds. The universe so vast seems to have been fitted up for such a purpose, and nothing else that we can conceive of will be so adapted to give employment without weariness to the minds that God has made in the interminable durations before them."—BARNES' *Commentary on Peter*, iii. 10.

"The study of the heavens," says the Rev. Mr. Crampton in his charming little volume "The Lunar World," "is the study of the glory of God. If, then, it be permitted to man hereafter, like those bright spirits of whom we read in Holy Writ, to roam with the speed of light, from world to world, from planet to planet, and from sun to sun, astronomy is no lost science, and the time that we have given to it is no lost time, for we shall only enter upon its fuller attainment in the world to come."—P. 86.

present generation, and estimate those that are yet to inherit the earth, we shall obtain a population which the habitable parts of our globe could not possibly accommodate. If there is not room then on our earth for the millions of millions of beings who have lived and died upon its surface, and who may yet live and die during the period fixed for its occupation by man, we can scarcely doubt that their future abode must be on some of the primary or secondary planets of the Solar system, whose inhabitants have ceased to exist like those on the earth, or upon planets in our own or in other systems which have been in a state of preparation, as our earth was, for the advent of intellectual life.

The connexion thus indicated between the destinies of the human family and the material system to which we belong, arising from the limited extent of the earth's habitable surface, and its unlimited population, is a strong corroboration of the views which we have deduced from Scripture. In the world of instinct the superabundance of life is controlled by the law of mutual destruction, which reigns in the earth, the ocean, and the air; but the swarm of human life, increasing in an incalculable ratio, both in the Old and the New World, has never been perceptibly reduced by the scythe of famine, of pestilence,

or of war; and when we consider the length of time during which this accumulation may proceed, we cannot justly challenge the correctness of the conclusion that this earth is not to be the future residence of the numerous family which it has been destined to rear. The connexion between this probable truth and the doctrine of a plurality of worlds, will appear from the facts and reasonings in the following chapter.

CHAPTER II.

DESCRIPTION OF THE SOLAR SYSTEM.

IN order to appreciate the force of the argument for a plurality of worlds, derived from the similarity of our Earth to the other planets of the Solar system, we must call the attention of the reader to a popular description of the magnitudes, distances, and general phenomena of the different bodies that compose it.

There is, perhaps, no sight in the material world more magnificent than that of the starry firmament. Seen from our earliest years, it may have ceased to excite our wonder, but no sooner has science taught us its true nature than it reappears in all its glory, like the gloomy landscape whose varied beauties a burst of sun-light has revealed. In the stillness of night, when the moral world is asleep,—when the aspen leaf has ceased to flutter, and no sound is heard save that of the remote waterfall, or the restless ocean, or the zephyr breath among the distant foliage, the silver Moon, the brilliant Planet, and

the twinkling Star, are the beacon-lights which guide the eye through the brilliant expanse above.

The orbs of heaven seem at first fixed and motionless, like the scene around, but ere long, before our survey or our reverie is over, we perceive that they have all been in motion. The Moon has neared the horizon: one Planet has descended in the West,—another has risen from the Eastern sea, and every star in the sky has shared in the general movement. When the observer has discovered that he alone has moved,—that, night after night, the Moon and Planets have alone changed their place among the stars, and that the Earth on which he stands, and the planets, whose motion he has observed, form a system of their own, while the thousands of stars, among which they moved, are fixed at distances invariable, he has arrived at the leading truths in astronomy.

But to the contemplative mind, the firmament of stars and planets has a deeper interest. Everything around us, save it, is in a state of transition. Beside the fleeting changes which the return of the seasons brings, the landscape around us is every year changing its aspect. The heath is robbed of its purple, and the yellow harvest waves over its once russet breast. The forests of our youth have ceased

to give us shelter,—now the roof-trees of our homes, —now the floating bulwarks on the deep. The very places of our birth have been removed or effaced, and the lichen has encrusted the record on the tombstones of our fathers. All around is change,—but the gorgeous creations in the sky are still there, undimmed in brightness—unchanged in grandeur, —performing, with unflagging pace and unvarying precision, their daily, their annual, and their secular rounds. Upon these same heavens, just as we see them now, bespangled with the same planets and the same stars, our first parents gazed when they entered and when they quitted Paradise. The same constellations, Arcturus, Orion, and the Pleiades had sung together when the foundations of the world were laid,[1] and they rolled in darkness over Calvary, when the Prince of Life was slain. They are truly the only objects in the universe which all nations have witnessed, and all people admired. They presided at the horoscope of our birth, and they will throw their pale radiance over the green mounds beneath which we are destined to lie.

Such are the associations with which we look at the firmament above, and deep must be the interest with which we contemplate the history and purpose

[1] Job ix. 9.

of its mysterious forms. It was, doubtless, under such associations that the great Philosopher of Mind[1] gave utterance to the feelings with which he contemplated the two cardinal phases of the physical and the moral world.

> **Methinks I ever tremble when I scan**
> **The Starlit Heavens, the sense of Right in Man.**

In surveying the material universe thus shadowed forth in the firmament, the first and the grandest object which arrests our attention is the glorious SUN,—the centre and soul of the solar system,—the lamp that lights it, the fire that heats it,—the magnet that guides and controls it,—the fountain of colour which gives its azure to the sky, its verdure to the fields, its rainbow hues to the gay world of flowers, and the "purple light of love" to the marble cheek of youth and beauty. This globe, probably of burning gas, enveloping a solid nucleus, is 880,000 miles in diameter, above a hundred times that of our globe, and five hundred times larger in bulk than all the planets put together! It revolves upon its axis in twenty-five days, and throws off its light with the velocity of 192,000 miles in a second. Sometimes by the naked eye, but frequently even by small

[1] Immanuel Kant.

telescopes, large black spots, many thousand miles in diameter, are seen upon its surface, and are evidently openings in the luminous atmosphere, through which we see the opaque solid nucleus, or the real body of the sun.

Around, and nearest the sun, at a distance of thirty-six millions of miles, revolves the planet MERCURY, with a day of twenty-four hours, and a year of eighty-eight days. Supposing the light of the sun to decrease as the square of the distance, he will receive nearly seven times as much light and heat as the earth. Through the telescope some astronomers have observed spots on his surface, and mountains several miles in height.

Next to Mercury the planet VENUS revolves at the distance of sixty-eight millions of miles, with a day of nearly twenty-four hours, and a year of 225 days. Her diameter is 7,700 miles, a little less than that of the earth. She changes her phases like the moon, exhibits spots on her surface, and, according to Schroeter, has an atmosphere and mountains nearly twenty miles in height. The light and heat which she receives from the sun is about double of that which is received by the earth.[1]

[1] From the rare appearance and want of permanence in the spots of Mercury and Venus, Sir John Herschel is of opinion,

The next body of the Solar system is our own EARTH—our birthplace, and soon to be our grave. Its distance from the sun is ninety-six millions of miles; its equatorial diameter 7,926 miles; the length of its year 365 days six hours, and of its day twenty-four hours. The form of the Earth is that of a sphere flattened at the poles like an orange, the difference of its diameters being 26½ miles. Its superficies is divided into continents and seas, the continents occupying *one-third*, and the seas *two-thirds* of its whole surface. The land, sometimes level and sometimes undulating, occasionally rises into groups and ranges of mountains, the highest of which does not exceed five miles. The Earth is surrounded with an aerial envelope or atmosphere, which is computed to be about forty-five miles in height, though the region of clouds does not reach much above the summits of the highest mountains.

The Earth is accompanied by a MOON or satellite, whose distance is 237,000 miles, her diameter 2,160 miles, and the time of her revolution round the Earth twenty-eight days. Her surface is composed

"that we do not see as in the moon the real surface of these planets, but only their *atmospheres*, much loaded with clouds, and which may serve to mitigate the otherwise intense glare of their sunshine."—*Outlines of Astronomy*, § 509.

of hill and dale, of rocks and mountains nearly two miles high, and of circular cavities, sometimes five miles in depth, and forty in diameter, which are believed to be the remains of extinct volcanoes. She possesses neither *lakes* nor *seas;* and we cannot discover with the telescope any traces of living beings, or any monuments of their hands, though we hope that these objects will be seen with some magnificent telescope which may yet be constructed. Viewing the Earth as the *third* planet in order from the sun, can we doubt that it is a globe like the rest, poised in ether like them, and, like them, moving round the central luminary?

Next, beyond the Earth, is the red-coloured planet MARS, with a day of about twenty-five hours, and revolving round the sun in 687 days, at the distance of one hundred and forty-two millions of miles. His diameter is 4,100 miles, and his surface exhibits spots of different hues,—the seas, according to Sir John Herschel, being *green*, and the land *red*. The spots which have been seen on this planet by several astronomers, are not always equally distinct, but when seen "they offer," as Sir John Herschel observes, "the appearance of forms, considerably definite and highly characteristic, brought successively into view by the rotation of the planet,

from the assiduous observation of which it has even been found practicable to construct a rude chart of the surface of the planet. The variety in the spots may arise from the planet not being destitute of atmosphere and cloud; and what adds greatly to the probability of this, is the appearance of brilliant white spots at its poles, which have been conjectured, with some probability, to be snow, as they disappear when they have been long exposed to the sun, and are greatest when just emerging from the long night of their polar winter, the snow line then extending to about six degrees from the pole."[1] In a sketch of this planet, as seen in the pure atmosphere of Calcutta by Mr. Grant, it appears, to use his words, "actually as a little world," and as the Earth would appear at a distance with its seas and continents of different shades.

Hitherto we have been surveying worlds at a respectful distance from each other, and having days, and nights, and seasons, and aspects, of the same character; but we now arrive at a region in space where some great catastrophe has taken place. At the distance of about two hundred and fifty millions of miles from the sun, corresponding to a period of about 1,500 days, astronomers long ago

[1] *Outlines of Astronomy*, § 510.

predicted the existence of a large planet, occupying the wide space between Mars and Jupiter. In the beginning of the present century, one very small planet was discovered in this locality by M. Piazzi; and after other two had been discovered, one by himself and the other by Mr. Harding, Dr. Olbers hazarded the opinion that the *three* planets were fragments of a larger one which had burst; and this remarkable theory has been almost placed beyond a doubt by the discovery, in the same place, of *thirty* fragments in all, chiefly by M. Gasparis of Naples, and our eminent countryman Mr. Hind, by whom no fewer than *ten* of these bodies have been discovered.

The following table contains the distances from the sun, and the periodic times of these remarkable bodies, the distance of the earth being unity or 1,—

	Mean distance from Sun.	Periodic Time in Years.		Mean distance from Sun.	Periodic Time in Years.
Ceres,	2.767	4.604	Hygeia,	3.151	5.594
Pallas,	2.772	4.617	Parthenope,	2.448	3.830
Juno,	2.669	4.360	Victoria,	2.335	3.568
Vesta,	2.361	3.629	Egeria,	2.582	4.150
Astræa,	2.577	4.138	Irene,	2.582	4.149
Hebe,	2.425	3.777	Eunomia,	2.640	4.289
Iris,	2.385	3.684	Psyche,	2.947	5.058
Flora,	2.201	3.267	Thetis,	2.480	3.904
Metis,	2.387	3.681	Melpomene,	2.294	3.475

	Mean distance from Sun.	Periodic Time in Years.		Mean distance from Sun.	Periodic Time in Years.
Fortuna,	2.446	3.825	Phocea,	2.393	3.704
Massilia,	2.449	3.833	Themis,	3.160	5.622
Calliope,	2.913	4.972	Euterpe,	3.347	5.597
Lutetia,	2.434	3.800	Bellona,	2.781	4.640
Thalia,	2.625	4.257	Amphitrite,	2.557	5.153
Proserpine,	2.653	4.324	Another, not named.		

The distance of *Flora*, the *nearest* of these asteroids, is 2.201, and its period 3.267 years; and that of *Euterpe*, the most distant, 3.347, with a period of 5.597 years. While this sheet was printing, Mr. Hind discovered the thirtieth of these planets, making the *tenth* discovered by himself.

Beyond this remarkable group is situated the planet JUPITER, a world of huge magnitude, 1,320 times greater in bulk than our Earth, revolving round its axis in ten hours, and round the sun in 4,333 days, (a little less than twelve years,) at the distance of four hundred and eighty-five millions of miles. His form is that of an oblate spheroid, his equatorial being to his polar diameter as 107 to 100. His diameter is 90,000 miles, and he is attended by *four Moons*, or satellites, the average size of which is a little greater than that of our moon. His surface exhibits bright spots and dark bands or

belts, which, though they have always the same direction, vary in breadth and in position, occasionally running out into branches or subdivisions, and dark spots. Sir John Herschel is of opinion, that the belts are tracts of corresponding clear sky in the planet's atmosphere, through which the darker body of the planet is seen, and that they are produced by currents like our trade-winds, but of a more steady and decided character, owing to the great velocity of his daily rotation.

The following are the periods and distances of Jupiter's satellites,—

	Periods.			Distances in Radii of Jupiter.
	Days.	Hours.	Min.	
1.	1	18	28	6.049
2.	3	13	15	9.623
3.	7	3	43	15.350
4.	16	16	32	26.998

Next to Jupiter is the remarkable planet SATURN, accompanied with *eight* satellites, and surrounded by a *ring*. The distance of Saturn from the sun is eight hundred and ninety millions of miles, his annual period twenty-nine and a half years, and the length of his day ten and a half hours. His diameter is 79,000 miles, and his equatorial is to his polar diameter as 12 to 11. According to very recent observations, the ring is divided into four different

rings, as shewn in the gilt figure of Saturn. Mr. Jacob has distinctly seen a fine division through more than half the circumference of the outer ring. It appears from some recent observations of Mr. Hippisley, that the middle ring is convex, and thicker in the middle than at either of its edges, and that the outer ring is sensibly raised above the edge of the inner. Mr. Bond, who thinks that the rings are fluid, is of opinion that the number of rings is continually changing, and that their maximum number, in the normal condition of the mass, does not exceed *twenty*. According to Mr. Bond, the power which sustains the centre of gravity of the *ring* is not in the planet itself, but in his satellites; and the satellites, though constantly disturbing the ring, actually sustain it in the very act of perturbation.

Mr. Otto Struve and Mr. Bond have lately studied, with the great Munich telescope, at the observatory of Pulkowa, the *third* ring of Saturn, which Mr. Lassell and Mr. Bond found to be *fluid*, from having observed through it the body of the planet, which is of an amber brown colour, as if seen through a film of smoke, the colour of the ring, when seen off the planet being of a slaty character. The principal division of the outer ring is not black, but of an

amber brown.[1] They saw distinctly the dark interval betwecn this fluid ring and the two old ones, and even measured its dimensions; and they perceived at its inner margin an edge feebly illuminated, which they thought might be the commencement of a fourth ring. These astronomers are of opinion, that the fluid ring is not of very recent formation, and that it is not subject to rapid change; and they have come to the extraordinary conclusion, that the inner border of the ring has, since the time of Huygens, been gradually approaching to the body of Saturn, and that *we may expect sooner or later, perhaps in some dozen of years, to see the rings united with the body of the planet.*

The following are the dimensions of Saturn's rings, when they were supposed to be only two in number, according to the measurements of Struve, one second corresponding to 4,400 miles—

		Miles.
1. Exterior diameter of the *Exterior* ring,	40″.095	176,418
2. Interior diameter of the Exterior ring,	35″.289	155,272
3. Exterior diameter of the *Interior* ring,	34″.475	151,690
4. Interior diameter of the Interior ring,	26″.668	117,389
5. Equatorial diameter of Saturn, . .	17″.991	79,160
6. Distance of the Interior ring from planet,	4″.339	19,090
7. Breadth of the division between the rings,	0″.408	1,791
8. Thickness of the ring, ...	0″.050	220

[1] These observations on the colour of the part of Saturn seen through the transparent ring, and on the division of the outer ring, were made by Mr. Jacob at Madras.

A singular fact in the structure of Saturn, not yet explained, was observed by Struve, who found that the inner edge of the interior ring was 943 miles nearer the body of the planet on the west side than on the east side.

The following table shews the distances and periodic times of the satellites of Saturn,—

	Periods. Days.	Hours.	Min.	Distance in Radii of Saturn.
1. Mimas,	0	22	37	3.361
2. Enceladus,	1	9	53	4.312
3. Tethys,	1	21	18	5.340
4. Dione,	2	17	42	6.840
5. Rhea,	4	12	25	2.553
6. Titan,	15	22	41	22.145
7. Hyperion,	22	12	0	28.
8. Japetus,	79	7	54	64.

The seventh satellite, Hyperion, was lately discovered on the same night by Mr. Lassell, Liverpool, and Professor Bond of Cambridge, U.S.

Beyond Saturn, at a distance from the sun of one thousand eight hundred millions of miles, is placed the planet URANUS, discovered by Sir William Herschel. Its year, or annual period, is eighty-four years, and the length of its day nine and a half hours. Its diameter is 34,500 miles, and it is attended by *eight* satellites, six of which were dis-

covered by Sir William Herschel, and the other two, a few years ago, by Mr. Lassell of Liverpool.

The following are the periods and distances of the satellites of Uranus.

	Periods.			Distances in Radii of Uranus.
	Days.	Hours.	Min.	
1.	4	0	0	
2.	8	16	56	17.0
3.	10	23	0	19.8
4.	13	11	7	22.8
5.	38	2	0	45.5
6.	107	12	0	91.0

The remotest planet of our system, the planet NEPTUNE, discovered theoretically in 1846 by Adams and Leverrier, and first recognised in the heavens by M. Galle of Berlin, is about 42,000 miles in diameter, and performs its annual revolution in 60,127 days (about 165 years,) at the distance of nearly *three thousand millions* of miles from the sun. It is accompanied with one, or probably two, satellites; and there is reason to believe that it is surrounded with a ring like Saturn. The satellite discovered by Mr. Lassell revolves round the planet in five days and twenty-one hours, at the distance of about 252,000 miles, or twelve radii of the planet.

Having thus travelled from the centre to the

verge of the planetary system,—from the effulgent orb of day to that almost cimmerian twilight where Phœbus could scarcely see to guide his steeds, let us ponder a while over the startling yet instructive sights which we have encountered in our course. Adjoining the sun, we find Mercury and Venus, with days and seasons like ours. Upon reaching our own planet, we recognise in it the same general features, but we find it larger in magnitude, and possessing the additional distinction of a satellite and a race of living beings to rejoice in the pre-eminence. In contrast with Mars, our earth still maintains its superiority both in size and equipments; but, upon advancing a little farther into space, our pride is rebuked and our fears evoked, when we reach the part of our system where *thirty* asteroids, relics of a once mighty planet, are revolving in dissevered orbits, and warning the vain astronomer of another world that a similar fate may await his own. Dejected, but not despairing, we pass onward, and, as if in bright contrast with the confusion and desolation we have witnessed, there bursts upon our sight the splendid orb of Jupiter, proudly enthroned amid his four attendant satellites. When compared with so glorious a creation, our own earth dwindles into insignificance. It is no

longer the monarch of the planetary throng, and we blush at the recollection that sovereigns and pontiffs, and even philosophers, made it the central ball, around which the Sun and Moon and planets, and even the stars themselves, revolved in obsequious subjection. The dignity of being the seat of intellectual and animal life, however, still *seems* to be our own; and if our globe does not swell so largely to the eye, or shine so brightly in the night, it has yet been the seat of glorious dynasties,—of mighty empires,—of heroes that have bled for their country, —of martyrs who have died for their faith,—and of sages who have unravelled the very universe we are surveying. Pursuing our outward course, a new wonder is presented to us in the gorgeous appendages of Saturn, encircled with his brilliant rings, and with eight moons, for the use, doubtless, of living beings. Advancing onwards, we encounter Uranus, with his eight pledges that he is the seat of life; and after passing the new planet Neptune, and his one or probably two attendants, at the frontier of our system, we reach what is the region, and what may be regarded as the home, of comets.

COMETS, or wandering stars, as they have been called, are those celestial bodies most of which appear occasionally only within the limits of the

Solar system. They move in elliptical orbits, in one of the foci of which the sun is placed; but, unlike the planets, which always move from west to east, the comets revolve in orbits inclined at all possible angles, and move in all possible directions. The movements of several hundred comets which have been observed, must be chiefly executed within that vast and untenanted region, which lies between the nearest known fixed star and the orbit of *Neptune*, an interval equal to six thousand times the distance of that planet from the sun, or twenty-one million million of miles. What is their occupation there, or what it is here, when they are our visitors, we cannot venture to guess. That they do not perform the functions of planets is obvious, from their very nature; and there is no appearance of their importing anything but vapour into our system, or of their exporting anything to another.

The general appearance of a comet is that of a faint round nebula, densest in the centre, like a piece of pale cloud through which stars are visible. Many of these comets have tails, increasing as they approach the sun. These tails are sometimes short, and sometimes so long as to stretch from the horizon to the zenith. The great comet of 1680, which produced such a sensation in London, was visible

for four months. Its greatest distance from the sun was estimated at 127 times the distance of the earth from the sun. Its tail was 120 millions of miles long, and its velocity 880,000 miles in an hour. When it was nearest the sun its distance from him was only 144,000 miles, or about one-sixth of the sun's diameter, and its heat from this cause so great that Sir Isaac Newton computed it to be 2,000 times that of red-hot iron. Dr. Halley made its period only 575 years, but Encke makes it 8,800, and Argelander 2,888 years.

A comet still more remarkable was seen in England on the 17th March 1843. Its nucleus had the appearance of a planetary disc, and had the brightness of a star of the first or second magnitude. It had a double tail divided by a dark line. At the Cape of Good Hope it was seen in full daylight, and in the immediate vicinity of the sea; but the most remarkable fact in its history was its near approach to the sun, its distance from his surface being only *one fourteenth* of his diameter. The heat to which it was exposed, therefore, was much greater than that which Sir Isaac Newton ascribed to the comet of 1680. Sir John Herschel has computed that it must have been 24 times greater than that which was produced in the focus of Parker's burning lens,

32 inches in diameter, which melts crystals of quartz and agate. In the interesting work *On cometic orbits* by Edward Cooper, Esq. of Markree Castle, the periods of those comets that move in elliptic orbits vary from four years to about 15,000; but for obvious reasons, we cannot place much confidence in the higher numbers.

The tails of comets have occasionally exhibited very remarkable phenomena. In some, such as that of 1825, the tail consists of several streams of diverging light in a state of quick and constant change. The nucleus of the comet of 1811 sent out rapid coruscations to the very end of its tail; and the comet of 1824 exhibited two tails diametrically opposite, the one directed to the sun being the smallest and faintest.

Some comets have passed near the earth, and others may pass still nearer it; but even if they should not produce those tremendous effects which Laplace has indicated, and if their great rarity and rapid motion should hinder them from acting upon our seas, or changing the axis of our globe, a sweep of their train of gas or of vapour would not be a pleasing salutation to living beings. The greatest distance of the most distant comet that has been observed, falls short of the distance of the nearest

fixed star by *nine million million of miles*. Placing ourselves at this distance, how ridiculous appears the idea, so long and devoutly cherished, that the heavens, with all their host, revolved round our little planet! At that point the earth is not even visible, and the whole starry creation, and our sun itself dwindled into a star, stand fixed and immovable.

Till within the last forty years it was the universal belief among astronomers that every comet strayed far beyond the limits of the Solar system, the shortest period of any of those that had been observed being about *seventy* years, indicating the immense distance which it must have traversed beyond the orbit of Neptune. In 1818, however, M. Pons discovered a comet, now called *Encke's Comet*, whose period was not above *three years* and *five months*, and whose orbit, extending inwards as far as that of Mercury, did not reach beyond the orbit of Pallas. Other *five* comets, whose periods are $5\frac{1}{2}$, $5\frac{4}{7}$, $6\frac{3}{4}$, $7\frac{1}{2}$, and sixteen years, have been discovered within the limits of our system. Among these bodies, the *comet of Biela*, discovered in 1826, appeared to separate *into two distinct comets* with parallel tails, but after a certain time it resumed its single state. M. Damoiseau having predicted that this comet would pass within

18,000 miles of a point in the earth's orbit, the publication of this fact excited such an alarm in Paris, that M. Arago was summoned from his studies to allay the terror of the community, The fears of the people, however, will not appear unreasonable, when we recollect that Sir John Herschel has stated that the orbit of this comet "so nearly intersects that of the earth, that an actual collision is not impossible, and indeed must in all likelihood happen in the lapse of some millions of years !"

A seventh comet belonging to our system, called *Lexell's Comet*, which that astronomer discovered in 1770, is supposed *to have been lost*, as it ought to have appeared *thirteen* times, and has not been seen since that date. It is thought to have been rendered invisible in 1779 by the action of Jupiter, but in what way astronomers have not been able to determine.

The following popular view of the relative sizes and distances of the planets which compose the Solar system has been given by Sir John Herschel :—

	Size.	Diameter of orbit in feet.	Real dist. in million of miles.
The Sun,	a Globe two feet in diameter,	0	
Mercury,	a Mustard Seed,	164	36
Venus,	a Pea,	214	61
Earth,	a larger Pea,	430	96

	Size.	Diameter of orbit in feet.	Real dist. in million of miles.
Mars,	a large Pin's head,	654	142
Juno, Ceres, Vesta, Pallas, and the other 29 Asteroids,	Grains of Sand,	1,000 to 1,200	250
Jupiter,	an Orange,	Half a mile,	485
Saturn,	a small Orange,	One mile and a fifth,	899
Uranus,	a Cherry,	One mile and a half,	1,800
Neptune,	a Plum,	Two miles and a half,	3,000

To which we may add,

The greatest distance of a Comet,	Eight thousand miles.
Distance of nearest Fixed Star,	Fifteen thousand miles.

The science which presents such objects to our contemplation, "constitutes," to use the language of Admiral Smyth, in concluding his admirable work, *A Cycle of Celestial Objects*, "a sort of scrutiny into futurity, and truly elevates the mind above the mundane system. We cannot see, without peculiar emotion, that the great law of gravitation is decidedly extended through the vast heavens, and that all the perceptible universe is amenable to the operation of time and space, motion and force, in similar relation to our own. *Thus the whole firmament, with its countless and glorious orbs, which, though sustaining apparently independent positions, are but individual constituents of one Majesty of creation, countenances the sagacity of the ancient dogma, that* GOD WORKS BY GEOMETRY."

CHAPTER III.

THE GEOLOGICAL CONDITION OF THE EARTH.

IN the preceding brief description of the Solar system, we see distinctly the relation which our own Earth bears to the other planets, in its position, its form, its magnitude, its satellite, and its daily and annual motions. But though a comparison of these properties of the earth, which constitute what may be called its *astronomical condition*, with the analogous properties of the other planets, might entitle us to ascribe to them other functions,—the function, for example, of supporting inhabitants, which the earth only is known to possess, yet our argument will derive new strength, and we shall be prepared to meet recent objections, by taking into consideration the geological structure of the earth, and the properties of its atmosphere, and by endeavouring to read its past history in the successive steps by which it has been prepared as a residence for the human family.

There is no branch of science so closely associated

with our immediate wants and enjoyments as that of Geology. In our daily walks we tread with heedless step upon the apparently uninteresting objects of which it treats; but could we rightly interrogate the rounded pebble in our path, it would tell us of the convulsions by which it was wrenched from its parent rock, and of the floods by which it was abraded and placed beneath our feet. In our visits to the picturesque and the sublime, we come into still closer proximity to geological truths. In the precipices which defend our rock-girt Isle, and flank our mountain glens, and in the shapeless fragments at their base which the lichen colours, and round which the ivy twines, we see the remnants of uplifted and shattered strata which once peacefully reposed at the bottom of the ocean. Nor does the rugged or the rounded boulder give a less articulate response from its lair of sand or its grave of clay. Floated by ice from some alpine summit, or hurried along in torrents of mud or of water, it may have traversed a quarter of the globe, amid the crash of falling forests and the death-shrieks of the animals which they lodged. The mountain-range, too, with its catacombs beneath, along which the earthquake transmits its terrific sounds, reminds us of the mighty powers by which it was upheaved, while

the lofty peak with its cap of ice or its nostrils of fire reveals the tremendous agencies which have been struggling beneath us.

But it is not merely among the scenes of external nature that forces, now subdued, are presented to our minds. Our temples and our dwellings are formed from the rocks of a primæval age,—bearing the ripple marks of a Pre-Adamite ocean,—ground by the friction of the once-travelling boulder, and embosoming the relics of ancient life, with the plants which sustained it. Our houses are ornamented with variegated limestones the indurated tombs of molluscous life, and our apartments heated with the carbon of primæval forests, and lighted with the gaseous element which it confines. The obelisk of granite and the monument of bronze which transmit to future ages the deeds of the hero and the sage, are equally the production of the earth's prolific womb, and from the green bed of the ocean have been raised the spotless marble to mould the divine lineaments of beauty, and perpetuate the expression of intellectual power. From a still greater depth the primæval rocks have yielded a rich tribute to the chaplet of wealth, and the processes of art. The diamond and the sapphire and the ruby that shine in the imperial diadem, are also the valued tools of the

artisan ; and the topaz, the emerald and the chrysoberyl have been scattered from the jewel caskets of our mother earth, to gratify the vanity of her children.

When the geologist begins his survey of the globe, he finds its solid covering composed of rocks, and beds of all shapes and kinds, lying at every possible angle, and occupying every possible position. Here the granite rises in lofty peaks, or is scattered in rounded boulders. There the basalt throws its once liquid current over beds of sandstone, or sustains them upon its flanks. Here the strata, once at the bottom of the sea, rest in undisturbed tranquillity—the more recent deposits from a tranquil ocean. There they bristle up with their rugged margin, displaying, in serrated outline, the fractured edges of ancient and of recent beds. Everywhere indeed, what was deep is brought into visible relation with what was superficial,—what is old with what is new,—what preceded life with what followed it.

How these rocks came into their present place it is the business of the geologist to determine,—to compute their relative ages,—to fix the position which they originally occupied,—to study the forces by which they were upheaved,—and the remains of organic life which they entomb. Studies like

these possess a home interest for reflecting and sympathizing man. Life claims kindred with what once lived. It owns the same relation between itself and that which is yet to breathe ; and if on the tombs of our fathers is inscribed the law under which we are individually to join them, we read with no less distinctness among the cemeteries of primeval death that more general enactment under which the races of man, and the tributary creation which obeys him, shall take their place in the coming catastrophe, and reappear to future pilgrims—memorials of the age of genius—the cycle of intellectual and immortal generations.

Thus identified with astronomy, in proclaiming truths supposed to be hostile to Scripture, Geology has been denounced as the enemy of religion. The twin sisters of terrestrial and celestial physics have thus been joint-heirs of intolerance and persecution —unresisting victims in the crusade which ignorance and fanaticism are ever waging against science. When great truths are driven to make an appeal to reason, knowledge becomes criminal, and philosophers martyrs. Truth, however, like all moral powers, can neither be checked nor extinguished. When compressed, it but reacts the more. It crushes where it cannot expand,—it burns where it is not

allowed to shine. Human when originally divulged, it becomes divine when finally established. At first, the breath of a sage—at last it is the edict of a god. Endowed with such vital energy, astronomical truth has cut its way through the thick darkness of superstitious times, and, cheered by its conquests, geology will find the same open path when it has triumphed over the less formidable obstacles of a civilised age.

The Earth, as we have seen, when merely examined by the eye, consists of land and water. The land is composed of soils of various kinds, and of stones and rocks of different characters. It is formed into extensive plains, into valleys excavated apparently by rivers or water-courses, and into mountain groups and mountain ranges, rising to the height of several miles above the bed of the ocean. In order to obtain a knowledge of the structure of the earth, geologists have examined with the greatest care its rocks, its soils, and its accumulations of clay or of gravel, wherever they have been laid bare by artificial or natural causes, by the operations of the miner, or the road engineer, by the cuttings for railways, or by the action of rivers or of the sea; and they have thus obtained certain general results which give us an approximate idea of the different materials which compose what is called the *crust of the earth*. In

those portions of its surface, which do not rise into mountains, the thickness of the crust thus explored does not exceed *ten or twelve miles*, which is only about the 700th part of the earth's diameter,—a quantity so small, that if we represent the earth by a sphere having the same diameter as the cupola of St. Paul's, which is 140 feet, the thickness of the crust would be little more than *two inches*.

Beneath the crust lies the *Nucleus* of the earth, or its *kernel* or its frame-work, of the nature and composition of which we are entirely ignorant. We know only, by comparing the average density of the earth, which is about $5\frac{1}{2}$ times that of water, with the average density of the rocks near its surface, which is about $2\frac{1}{2}$ times that of water, that the density of the nucleus, if of uniform solidity, must exceed $5\frac{1}{2}$, and must be much greater if it is hollow or contains large cavities. Geology does not pretend to give us any information respecting the process by which the nucleus of the earth was formed. Some speculative philosophers indeed have presumptuously embarked in such an inquiry; but there is not a trace of evidence that the solid nucleus of the globe was formed by secondary causes, such as the aggregation of attenuated matter diffused through space; and the *nebular hypothesis*, as it has been called, which

we shall have occasion to explain in a subsequent chapter, though maintained in different forms by a few individuals, has been overturned by arguments that have never been answered. Sir Isaac Newton, in his four celebrated letters to Dr. Bentley, has demonstrated that the planets of the solar system could not have been thus formed, and put in motion round a central sun.

But though geologists have not been able to give us any intelligence, from actual observation, respecting the earth's *Nucleus*, they have examined the rocks which rest upon it, and extend upwards to the surface of the earth.

The *Primary* formations consist of granite rocks, trap, syenite, and porphyry. They are composed chiefly of the simple minerals, *Quartz*, *Feldspar*, *Mica*, and *Hornblende* or *Augite*. They are consequently crystalline and unstratified, and are believed to be of igneous origin.

The next series of rocks are what are called the *Metamorphic or altered rocks*. They consist of gneiss, mica slate, and clay slate, and are more or less stratified.

The other primary rocks are Basalt or ancient lava, and what are called Trachytic Rocks.

To all these rocks the name of *Azoic*, or *without life*, has been given, because they contain no organic remains either of plants or animals.

Above these Primary Rocks lie the fossiliferous formations, or those that contain fossils or organic remains.

Professor Ansted has divided them into three groups.

I. The *Palæozoic* group (or that of ancient life) consists of,—

1. The *Lower Silurian*, or *Protozoic* rocks, from their containing the first traces of life.
2. The *Upper Silurian* rocks.
3. The *Devonian* System, or Old Red Sandstone.
4. The *Carboniferous* system, the Lower New Red Sandstone, and the Magnesian Limestone, or Permian system.

II. The *Secondary* group consists of,—

1. The *Upper New Red Sandstone* of England, or the *Triassic formation* of Germany.
2. The *Liassic*, *Oolitic*, *Wealden* (*Jurassic*) formations; and,
3. The *Cretaceous* or chalk formation.

III. The *Tertiary formation* consists of,—

1. The *older tertiary* or *Eocene* group, viz., Bagshot sand and London clay.
2. The *middle tertiary*, or *Miocene* group, viz., Red and Coralline Crag.
3. The *newer tertiary*, or *Pliocene* group, viz., the Till of the Clyde Valley and Norwich Crag.
4. The *superficial deposits*, or *Pleistocene* group, viz., all diluvial and alluvial deposits of gravel and other materials, sometimes stratified.

The proportional thicknesses of these different formations have been estimated by Professor Phillips as follows, but the numbers can be regarded only as a very rude estimate :—

Tertiary formation, . . .	2,000 feet.
Cretaceous, ...	1,100 „
Oolite and Lias, . . .	2,500 „
New Red Sandstone, . .	2,000 „
Carboniferous, . . .	10,000 „
Old Red Sandstone, . .	9,000 „
Primary Rocks, . .	20,000 „

Thickness of the Earth's crust, 46,600 = 9 miles nearly.

We wish that we could give our readers some distinct information respecting the interior condition

of the Earth, the forces which it embosoms, and the manner in which they have upheaved the strata, caused volcanoes, and formed those mountain ranges and inequalities which diversify its external surface. While the geologist describes the present condition of the strata, it is the business of the mechanical philosopher to inquire into the causes by which they have been thrown into the places which they now occupy. This inquiry has been pursued with great ability and success by one of our most distinguished mathematicians, Mr. William Hopkins of Cambridge. In these inquiries the Earth is supposed to have been originally in a state of fluidity produced by heat, and its crust to have become solid by cooling, the solidification extending only to a certain depth, and the interior mass remaining in a fluid state. It had been often assumed by speculative geologists that the central portion of the Earth was fluid, and that its solid crust did not exceed ten or twelve miles in thickness. On these assumed data they founded different theories of volcanoes,—certain chemical philosophers ascribing them to the decomposition of water and air, which oxidize the solid materials, and generate heat sufficient to melt them, while others believe that the solid crust does not exceed twenty or thirty miles, and that water

descending through crevices to the melted mass is converted into steam, which by its elastic force produces an external eruption.

The theory of Mr. Hopkins is founded upon better data, and connects the causes of volcanic action with those which explain the general phenomena of the elevation of the strata. That the interior of the Earth is in a fluid state by heat is probable from the fact, that its temperature increases at the rate of 1° of Fahrenheit for every 65 feet in depth, so that at a depth of fifty miles the temperature would be twice that which would be sufficient to melt iron. At so great a depth the pressure of the superincumbent matter would be upwards of 200,000 pounds on the square inch; and as it appears from a series of interesting experiments, conducted by Mr. Hopkins, Mr. Fairbairn, and Mr. Joule, that the temperature at which many bodies melt is proportional to the pressure to which the melted mass is subjected, it follows that the Earth's solid crust may be much thicker than forty or fifty miles. The inference from these experimental results adds great weight to the conclusion which Mr. Hopkins had previously deduced from theoretical considerations. From the present amount of what astronomers call the precession

of the equinoctial points, arising from the nutation or oscillation of the Earth's axis, produced by the action of the Sun and Moon upon the redundant matter at the equator, he has shewn that the thickness of the solid shell or crust of the Earth cannot be less than one-fourth or one-fifth of the Earth's radius, that is, than 1,000 or 800 miles, and may be much greater. This result is quite incompatible with one of the volcanic theories which we have mentioned, as the fluid mass of the Earth is too remote from its surface to be forced out by the pressure of steam generated by means of water descending from above. Mr. Hopkins is therefore led to the conclusion that the fluid matters which produced external volcanoes, exist in internal reservoirs of limited extent, forming subterranean lakes, and not a subterranean ocean. The origin of these masses of fluid lava, or melted granite, he ascribes to the greater fusibility of the matter of which they consist, and he attributes their continuance in a state of fusion to the same cause, and to the removal of the consolidating influence of pressure, in consequence of their having, by expansion, raised into a permanent arch the superincumbent solid strata.

Instead of one continuous internal lake of melted

matter, a number of lakes may be connected with each other by more or less obstructed channels of communication. The vapours generated by heat in these fluid lakes, and acquiring elastic force, either from the rapidity of their production, or from long accumulation, will elevate the strata above them, sometimes by a slow and long continued process, and sometimes by a more rapid one; and when fissures or openings have been thus produced, the melted matter might either be ejected in volcanic eruptions,—or diffused through crevices, so as to form veins,—or poured out in beds over the surface of the superincumbent strata.

The elevations produced on the Earth's surface by these elastic forces will depend upon the length, and breadth, and depth, as well as upon the general form of the subterranean lakes of lava. In many cases the elevation in one place will be accompanied by a subsidence of the strata in another. When the cohesion of the strata is first overcome, fissures will be produced. The strata will in some cases be displaced, as in what is called a *fault*, in others *inverted*, as they are sometimes found to be; and when the elastic forces act horizontally, the strata will be *contorted* or *folded*.

During the sudden dislocations and explosive

actions which must accompany the upheaval of the strata, vibratory motions like waves, excited in the solid and fluid masses in the vicinity of the seat of upheaval, would be propagated to great distances through the solid crust, and produce those earthquakes which so often desolate particular regions of the globe.[1]

These views are well illustrated by the cavities which I discovered in topaz, quartz, and other minerals found in the primitive rocks. These cavities, which have every variety of shape, contain solid crystals, fluids, vapours, and compressed gases. When heat is applied to the specimens which contain them, it melts the solid crystals within them, converts the fluids into vapour, and either discharges the contents of the cavity between the fissures along the faces of cleavage, or ejects them when the crystal explodes and is burst in

[1] Mr. Hopkins's valuable researches will be found in the *Philosophical Transactions* for 1839, p. 38, 1840, p. 193, and 1842, p. 43, and in his interesting "Report on the Geological Theories of Elevation and Earthquakes," in the *Report of the British Association* for 1847, pp. 33-93. In two recent papers by Mr. Hennesy, entitled *Researches in Terrestrial Physics*, he has arrived at the conclusion that the least thickness of the Earth's crust cannot be less than eighteen miles, and its greatest thickness not greater than 600 miles. See *Philosophical Transactions*, 1851, p. 545.

pieces. By the separation of the laminæ, and by the agency of heat and other causes, electricity is generated and distinctly exhibited in the phenomena which accompany the bursting of the crystal. These cavities are often very long, and of the most extraordinary shapes, and sometimes several are connected together by narrow necks or channels, through which the solid, fluid, and gaseous contents of one cavity are discharged into the next.[1] In Brazilian topazes I have found cavities containing a white powder, which Berzelius analyzed for me, and found to consist of silex, alumina, lime, and water. This powder is undoubtedly the elements of topaz, which, like the materials in the lakes of the Earth's crust, have been prevented from solidifying.[2]

The formation of lakes of unmelted matter in the crust of the Earth is also beautifully illustrated in cavities of ice, which contain unfrozen water.[3] It is not necessary, therefore, to suppose that the lakes or cavities in the crust of the Earth consist of more fusible materials than the solid matter which sur-

[1] I have given a full account of these phenomena in the *Edinburgh Transactions*, vol. x. pp. 1, 407; vol. xvi. pp. 7, 11; and vol. xx. p. 547.

[2] *Cambridge Transactions*, 1822.

[3] *Edinburgh Transactions*, vol. x. p. 426.

rounds them. The materials have been prevented from solidifying by the gases which have been simultaneously imprisoned during the induration of the surrounding matter.

Admitting, then, the correctness of Mr. Hopkins's opinion that the elevation of mountain chains is produced by elastic forces, emanating from large subterranean lakes, or chains of lakes of melted lava within the solid crust of the Earth, it becomes interesting to inquire into the direction of those ranges of mountains which have been upheaved from the same subterranean lake at the same time. This inquiry has been pursued with much success by M. Elie de Beaumont, who has endeavoured to shew that all mountain chains, and consequently the great lines of dislocation through which they have been upheaved, may be grouped into parallel systems, and that all these lines or chains belonging to any single system were produced at the same time by one great convulsion of the Earth's crust. More recently, he has arrived at the conclusion that the lines of direction which characterize each group are not the effect of accident, but have such relations to each other, that the different groups or systems are symmetrically arranged over the Earth's surface, something like the lines of a dodecahedron. If we

combine this theory with Mr. Hopkins's theory of subterranean reservoirs or lakes of fluid lava, it will follow that these lakes have a symmetrical arrangement within the Earth's crust. Until we know the form of the bottom of our ocean, it will be difficult to compare these views extensively with the elevations on the Earth's surface.

As all the stratified formations which, with the primary rocks, compose the crust of the earth, have obviously been deposited in succession, geologists have endeavoured to form some notion of the time occupied in their deposition, or the age of the most ancient of them. By studying the fossil remains found in the different formations, it has been placed beyond a doubt, that great changes have taken place during the formation of the crust of the earth. The plants and animals which existed in one period are not found in another,—new species were at different times created,—and frequent convulsions have taken place, upheaving the beds of the ocean into continents and mountain ranges, causing continents and islands to subside, and covering the dry land with the waters which were thus necessarily displaced. That the deposition of strata of such thickness, and operations of such magnitude, required a long period of time for their accomplishment, has been willingly conceded to

the geologist; but this concession has been founded on the adoption of a *unit* of measure which may or may not be correct. It is taken for granted, that many of the stratified rocks were deposited at the bottom of the sea by the *same slow processes* which are going on in the present day; and as the thickness of the deposits now produced is probably a very small quantity during a long period of time, it is inferred that *nine* or *ten miles of strata* must have taken millions of years for their formation.

We are not disposed to grudge the geologist even periods so marvellous as this, provided they are considered as merely hypothetical; but when we find, as we shall presently do, that speculative writers employ these assumed periods as positive truths, for establishing other theories which we consider erroneous, and even dangerous, we are compelled to examine more minutely a chronology which has been thus misapplied.

Incerta incertis non probantur.

Although we may admit that our seas and continents have nearly the same locality, and cover nearly the same area as they did at the creation of Adam; and that the hills have not since that time changed their form or their height; nor the beds of the ocean become deeper or shallower from the diur-

nal changes going on around us,—yet this does not authorize us to conclude that the world was prepared for man by similar causes operating in a similar manner. The same physical causes may operate quickly or slowly. The dew may fall invisibly on the ground,—the gentle shower may descend noiseless on the grass,—or the watery vapour may rush down in showers and torrents of rain, destroying animal and vegetable life. The frozen moisture may fall in spiculæ or crystals of ice, which are felt only by the tender skin upon which they light;—or it may come down in flakes of snow, forming beds many feet in thickness;—or it may be precipitated in destructive hailstones, or in masses of ice which crush everything upon which they fall.

When the earth was completed as the home of the human family, violent changes upon its surface were incompatible with the security of life, and the progress of civilisation. The powers of the physical world were therefore put under restraint, when man obtained dominion over the earth; and after the great catastrophe which destroyed almost every living thing, the "bow was set in the clouds," a covenant, between God and man, that the elements should not again be his destroyer. If the Almighty then, since the creation of man, "broke up the foun-

tains of the deep, and opened the windows of the heavens," and thus, by apparently natural causes, covered the whole earth with an ocean that rose above the Himalaya and the Andes,—why may He not at different periods, or during the whole course of the earth's formation, have deposited its strata by a rapid precipitation of their elements from the waters in which they were dissolved or suspended? Chemical and physical forces of high activity may have been the agents in such summary operations, and in the beautiful process of the Electrotype, we have a striking example of the influence of electricity in effecting a rapid precipitation of metals from their solutions. The period of the earth's formation would, upon this principle, be reduced to little more than the united generations of the different orders of plants and animals which constitute its organic remains. But even the time thus computed, from the supposed duration of animal life, may be still farther shortened. Plants and animals which, in our day, require a century for their development, may in primitive times have shot up in rank luxuriance, and been ready, in a few days, or months, or years, for the great purpose of exhibiting, by their geological distribution, the progressive formation of the earth.

Nor is this a groundless supposition. From the age of plants and animals in the present day, we are not entitled to infer their age in primitive times. Without appealing to the influence of food and climate and soil on the growth of animal and vegetable bodies, we find the truth of our position in the history of our own species. During the first 2,000 years of the human era, the laws of vital organization were entirely different from what they are in the present day. From Adam to Abraham the age of man varied from 969 to 175 years, and gradually declined to the average of threescore and ten; and in like manner the plants and animals of primæval times, when they were required, as epochs in the chronology of creation, may have had a more luxuriant growth and a shorter existence.

There are other points, in geological theory, which, though *reasonable* inferences from a very limited number of facts, have been employed, as if they were *absolutely true*, to support erroneous and dangerous theories; and but for this misapplication of them we should not have called in question opinions in themselves reasonable only when viewed as probable truths. The geological inference to which we allude is, that man did not exist during the period of the earth's formation. No work of human skill—no

fragment of the skeleton—no remains of the integuments of man have been found among the plants and animals which occupy the graves of primæval times. If it be quite certain, or rather sufficiently credible, which we think it is, that all the formations with fossil remains were deposited before the advent of Adam, it is possible that pre-adamite races may have inhabited the earth simultaneously with the animals which characterize its different formations. But though possible, and to a certain extent available, as the basis of an argument against a startling theory, we do not admit its probability. Man, *as now constituted*, could not have lived amid the storms and earthquakes and eruptions of a world in the act of formation. His timid nature would have quailed under the multifarious convulsions around him. The thunder of a boiling and tempest-driven ocean would have roused him from his couch, as its waters rushed upon him at midnight: Torrents of lava or of mud would have chased him from his hearth; and if he escaped the pestilence from animal and vegetable death, the vapour of the subterranean alembics would have suffocated him in the open air. The house of the child of civilisation was not ready for his reception. The stones that were to build and roof it, had not quitted their native beds. The coal that was to

light and heat it, was either green in the forest, or blackening in the storehouse of the deep. The iron that was to defend him from external violence, and to perform the most important functions in the arts of life, lay buried in the ground; and the rich materials of civilisation, the gold, the silver, and the gems, even if they were ready, had not been cast within his reach, from the hollow of the Creator's hand.

But if man could have existed amid catastrophes so tremendous, and privations so severe, his presence was not required, for his intellectual powers could have had no suitable employment. Creation was the field on which his industry was to be exercised and his genius unfolded; and that Divine reason which was to analyze and combine, would have sunk into sloth before the elements of matter were let loose from their prison-house, and Nature had cast them in her mould. But though there was no specific time in this primæval chronology which we could fix as appropriate for the appearance of man, yet we now perceive that he entered with dignity at its close. When the sea was gathered into one place, and the dry land appeared, a secure footing was provided for our race. When the waters above the firmament were separated from the waters below it, and when the light which ruled the day, and the light which

ruled the night, were displayed in the azure sky, man could look upward into the infinite of space, as he looked downward into the infinite in time. When the living creature after his kind appeared in the fields, and the seed-bearing herb covered the earth, human genius was enabled to estimate the power, and wisdom, and bounty of its Author, and human labour received and accepted its commission, when it was declared from on high that seed-time and harvest should never cease upon the earth.

But though we think it probable from these considerations, that intellectual races could not occupy the earth during its formation, yet we know not what disclosures might be made had we the power of examining the whole of the strata which girdle the earth. The dry land upon our globe occupies only *one-fourth* of its whole superficies—all the rest is sea. How much of this *fourth* part have geologists been able to examine? and how small seems to be the area of stratification which has been explored? We venture to say not *one-hundredth* part of the whole, and yet upon the results of so partial a survey, there has been founded a startling generalization. The intellectual races, if they did exist, must have lived at a distance from the ferocious animals that may have occupied the seas and the jungles of the ancient

world, and consequently their remains could not have been found in the ordinary fossiliferous strata. Their dwelling-place may have been in one or more of the numerous localities of our continents not yet explored, in steppes and savannahs undisturbed by upheavals, or in those immense regions of the earth which are now covered by the great oceans of the globe; and till these oceans have quitted their beds, or some great convulsions have upheaved and laid bare the strata above which the races in question may have lived and died, we are not entitled to maintain it as a *demonstrated* truth, upon which we can found extravagant speculation, that the ancient earth was under the sole dominion of the brutes that perish.

But without waiting for the result of catastrophes like these, the future of geology, even if restricted to existing continents and islands, may be pregnant with startling discoveries; and the remains of intellectual races may be found beneath as well as above the primitive *Azoic* formations of the earth. The astronomers of the present day have penetrated far into the celestial depths, compared with those of the preceding age,—descrying in the remotest space glorious creations, and establishing mighty laws. Like them, may not geologists descend deeper into the abyss beneath, and discover in caverns yet unexplored the

upheaved cemeteries of primordial times. The earth has yet to surrender its strongholds of gigantic secrets, —and startling revelations are yet to be read on sepulchres of stone. It is not from that distant bourne where the last ray of starlight trembles on the telescopic eye that man is to receive the great secret of the world's birth, or of his future destiny. It is from the deep vaults to which primæval life has been consigned that the history of the dawn of life is to be composed. Geologists have read that chronology backwards, and are decyphering downwards its pale and perishing alphabet. They have reached the embryos of animal and vegetable existence, the probable terminus of the formation which has buried them. But who can tell *what sleeps beyond!* If we have followed the omnipotent arm into the infinity of space, may we not trace it under our feet in remoter times, and in deeper cemeteries? Another creation may lie beneath the earth's granite pavement,—more glorious creatures may be entombed there. The mortal coils of beings more lovely, more pure, more divine than man, may yet read to us the humbling lesson that we have not been the first, and may not be the last of the intellectual race.

In order to compare the condition of the earth with that of the moon and the other planets of the Solar

system, we must know something of its atmosphere, of its action in reflecting, and polarizing light, and of the phenomena which it will exhibit to other planets in its various states, as modified by the aqueous vapour which it contains, whether it exists in minute vesicles, or in masses of clouds. The light reflected by the atmosphere, when in its purest state, is a *rich blue*, becoming paler and paler as the aqueous vapour is increased. When the light of the sun reaches the eye, after having been transmitted through great lengths of atmosphere, it is bright *red*, passing into *orange* and *yellow* when the length of its path is diminished. Considering, then, the diversity of climate in any one hemisphere of the globe, it is hardly possible that the earth, as seen from any given point in space, could appear free from clouds. When the sky is blue over large portions of the tropical regions, and smaller portions of the temperate and arctic zones, it is elsewhere covered with fleecy clouds, or throwing down its superabundant vapours in rain, or hail, or snow. The banks of fleecy clouds will reflect a brilliant light to the distant eye, while the pure air will exhibit the colour of the land, or of the ocean, mixed with its own native tint of blue; and in certain positions of the sun, the red beams into which his pure rays have been changed by absorption, will

display themselves in certain parts of the terrestrial disc. When the earth, therefore, is reduced by distance to the apparent size of Mars and Jupiter, it will exhibit a tint composed of all those which we have described.

When the blue light of the sky, and the light reflected from the clouds, are examined by an observer on the surface of the earth, it is found to be polarized, like the light which is reflected from the surfaces of water, ice, and other transparent bodies, whether solid or fluid; and, therefore, a greater or less portion of the light reflected from our earth which reaches the eye of an observer, placed on another planet, must be polarized, and exhibit all the properties of that species of light.[1] In like manner, the light reflected from the air or from the clouds and water of other planets must contain polarized light. We thus obtain a certain test of the existence of water, air, and clouds in the other planets of the system, and are enabled to ascertain the truth of certain speculations respecting their condition, which affect the question of a plurality of worlds.

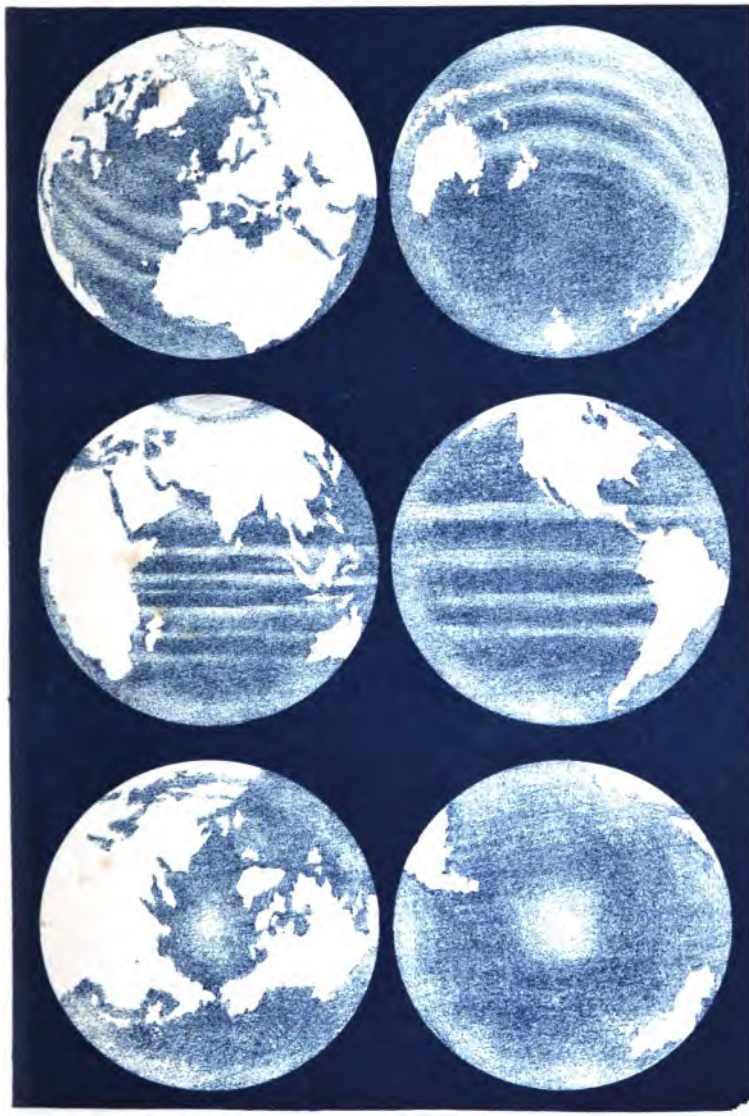
[1] See Johnston's *Physical Atlas*, Plate V. of *Meteorology*.

CHAPTER IV.

ANALOGY BETWEEN THE EARTH AND THE OTHER PLANETS.

WITH the information contained in the preceding chapter, respecting the structure of the Earth and its atmosphere, we are now in a condition to compare it as an inhabited world with the other planets of our system, and to ascertain, from the analogies which exist between them, to what extent it is probable that they are either inhabited, or in a state of preparation, as the earth once was, for the reception of inhabitants.

In making this comparison, the first point which demands our attention is the *position* which the earth occupies in the Solar system. In reference to the position of the planets, Jupiter may be regarded as the middle planet, and is otherwise highly distinguished. Our earth, therefore, is neither the *middle* planet nor the planet *nearest* the sun, nor the planet *farthest* from that luminary. In reference



THE EARTH VIEWED FROM SPACE.

to the light and heat which the planets receive from the sun, the Earth has neither the warmest, nor the middle, nor the coldest place. With respect to the number of moons or satellites, the only uses of which that we know, is to give light to the planet, and produce tides in its seas, the Earth has the lowest number, all the planets exterior to it having a larger number. If we compare it with the other planets in reference to their size, their form, their density, the length of their year, the length of their day, the eccentricity of their orbits, we shall find that in all these cases the Earth is not in any respect distinguished above the rest. Hence we are entitled to conclude that the Earth, as a planet, has no pre-eminence in the Solar system to induce us to believe that it is the only inhabited world, or has any claim to be peculiarly favoured by the Creator.

In order to shew the high probability that the other planets are either inhabited, or in a state of preparation for the reception of inhabitants, we shall now proceed to compare the Earth with the planet *Jupiter*, one of the planets farther from the sun than ours, and then with *Venus*, one of the planets nearer the sun,—these planets representing the two groups into which the system may be divided.

The diameter of Jupiter being 87,000 miles, and that of the Earth 7,926, the relative size or bulk of the two planets will be proportional to the cubes of these numbers. Hence the size or bulk of Jupiter is about 1,300 times greater than that of the Earth, and this alone is a proof that it must have been made for some *grand* and *useful* purpose. Like the Earth it is flattened at its poles, and it revolves round its axis in $9^h\ 56^m$, which is the length of its day. It enjoys different climates, and different seasons in its year; but, what especially demands our attention, it is illuminated by four moons, capable of supplying it with abundance of light during the short absence of the sun. Owing to the small inclination of Jupiter's axis to the plane of its orbit, which is only about *three* degrees, there is so little change in the temperature of its seasons, that it may be said to enjoy a perpetual spring. The rotation of the Earth about its axis produces currents in its atmosphere parallel to the equator, which have received the name of the *trade winds*. On the surface of Jupiter astronomers have observed streaks or belts to the number of thirty, some of which extend to a great distance from its equator. Large spots, which change their form, have also been frequently seen upon Jupiter. M. Madler, by whom these observations have been chiefly made,

is of opinion, that owing to the length of Jupiter's year, and the small change which takes place in the seasons, the masses of clouds in his atmosphere have their form, position, and arrangement more permanent than those in the atmosphere of the Earth, and he thinks it probable that the inhabitants in latitudes greater than 40° may never see the firmament.

The satellites of Jupiter afford him perpetual moonlight. They suffer eclipses like our moon when they encounter his huge shadow, and they frequently eclipse the sun when they pass between him and the planet. These satellites afford to their primary planet four months of different lengths, one of which is four Jovian days, and the others *eight*, *seventeen*, and *forty* days respectively.

With so many striking points of resemblance between the Earth and Jupiter, the unprejudiced mind cannot resist the conclusion that Jupiter has been created like the Earth for the express purpose of being the seat of animal and intellectual life. The Atheist and the Infidel, the Christian and the Mahometan,—men of all creeds and nations and tongues,—the philosopher and unlettered peasant, have all rejoiced in this universal truth; and we do not believe that any individual, who confides in the facts of astronomy, can seriously reject it. If such a person

exists, we would gravely ask him, for what purpose could so gigantic a world have been framed? Why does the sun give it days and nights and years? Why do its moons throw their silver light upon its continents and its seas? Why do its equatorial breezes blow perpetually over its plains? unless to supply the wants, and administer to the happiness of living beings.

In studying this subject, persons who have only a superficial knowledge of astronomy, though firmly believing in a plurality of worlds, have felt the force of certain objections, or rather difficulties, which naturally present themselves to the inquirer. The distance of Jupiter from the sun is so great that the light and heat which he receives from that luminary is supposed to be incapable of sustaining the same animal and vegetable life which exists on the Earth. If we consider the heat upon any planet as arising solely from the direct rays of the sun, the cold upon Jupiter must be very intense, and water could not exist upon its surface in a fluid state. Its rivers and its seas must be tracks and fields of ice. But the temperature of a planet depends upon other causes, —upon the condition of its atmosphere, and upon the internal heat of its mass. The temperature of our own globe *decreases* as we rise in the atmosphere,

and *approach* the sun, and it *increases* as we descend into the bowels of the earth and *go farther* from the sun. In the *first* of these cases, the increase of heat as we approach the surface of the Earth from a great height in a balloon, or from the summit of a lofty mountain, is produced by its atmosphere; and in Jupiter the atmosphere may be so formed as to compensate to a certain extent the diminution in the direct heat of the sun arising from the great distance of the planet. In the second case, the internal heat of Jupiter may be such as to keep its rivers and seas in a fluid state, and maintain a temperature sufficiently genial to sustain the same animal and vegetable life which exists upon our own globe.

These arrangements, however, if they are required, and have been adopted, cannot contribute to increase the feeble light which Jupiter receives from the sun; but in so far as the purposes of vision are concerned, an enlargement of the pupil of the eye, and an increased sensibility of the retina, would be amply sufficient to make the sun's light as brilliant as it is to us. The feeble light reflected from the moons of Jupiter would then be equal to that which we derive from our own, even if we do not adopt the hypothesis, which we shall afterwards have occasion to mention, that a brilliant phosphorescent light may

be excited in the satellites by the action of the solar rays.

Another difficulty has presented itself, though very unnecessarily, in reference to the shortness of the day in Jupiter. A day of *ten* hours has been supposed insufficient to afford that period of rest which is requisite for the renewal of our physical functions when exhausted with the labours of the day. This objection, however, has no force. Five hours of rest are surely sufficient for five hours of labour; and when the inhabitants of the temperate zone of our own globe reside, as many of them have done, for years in the arctic regions, where the length of the days and nights are so unusual, they have been able to perform their functions as well as in their native climates.

A difficulty, however, of a more serious kind is presented by the great force of gravity upon so gigantic a planet as Jupiter. The stems of plants, the materials of buildings, the human body itself, would, it is imagined, be crushed by their own enormous weight. This apparently formidable objection will be removed by an accurate calculation of the force of gravity upon Jupiter, or of the relative weight of bodies on its surface. The mass of Jupiter is 1,300 times greater than that of the Earth, so that if both planets consisted of the same kind of matter, a man

weighing 150 pounds on the surface of the Earth would weigh 150 × 1,300, or 195,000 pounds at a distance from Jupiter's centre equal to the Earth's radius. But as Jupiter's radius is *eleven* times greater than that of the Earth, the weight of bodies on his surface will be diminished in the ratio of the square of his radius, that is, in the ratio of 11 × 11, or 121 to 1. Consequently, if we divide 195,000 pounds by 121, we shall have 1,611 pounds as the weight of a man of 150 pounds on the surface of Jupiter, that is about *eleven* times his weight on the Earth. But the matter of Jupiter is much lighter than the matter of our Earth, in the ratio of 24 to 100, the numbers which represent the densities of the two planets, so that if we diminish 1,611 pounds in the ratio of 24 to 100, or divide it by 4.17, we shall have 393 pounds as the weight of a man on Jupiter, who weighs on the Earth only 150 pounds, that is, only about $2\frac{1}{2}$ times his weight—a difference which actually exists between many individuals on our own planet. A man, therefore, constituted like ourselves, could exist without inconvenience upon Jupiter; and plants, and trees, and buildings, such as occur on our own Earth, could grow and stand secure in so far as the force of gravity is concerned.[1]

[1] See Chap. XVI.

In removing difficulties, and answering objections such as these, we have conceded too much to the limited conceptions of the persons who have felt the one and urged the other. To assume that the inhabitants of the planets must necessarily be either men or anything resembling them, is to entertain a low opinion of that infinite skill which has produced such a variety in the form and structure and functions of vegetable and animal life. In the numerous races of man which occupy our globe, there is not the same variety which is exhibited in the brutes that perish. Although the noble Anglo-Saxon stands in striking contrast with the Negro, and the lofty Patagonian with the diminutive Esquimaux, yet in their general form and structure, and in their physical and mental powers, they are essentially the same. But when we look into the world of instinct, and survey the infinitely varied forms which people the earth, the ocean, and the air;—when we range with the naturalist's eye from the elephant to the worm—from the leviathan to the infusoria—and from the eagle to the humming bird, what beauty of form—what diversity of function—what variety of purpose is exhibited to our view! In all these forms of being, reason might have been given in place of instinct, and animals the most hostile to man, and the most alien to his habits,

might have been his friend and his auxiliary, in place of his enemy and his prey. If we carry our scrutiny deeper into nature, and survey the infinity of regions of life which the microscope discloses, and if we consider what other breathing worlds lie far beyond even its reach, we may then comprehend the variety of intellectual life with which our own planets and those of other systems may be peopled. Is it necessary that an immortal soul should be united to a skeleton of bone, or imprisoned in a cage of cartilage and of skin? Must it see with two eyes, and hear with two ears, and touch with ten fingers, and rest on a duality of limbs? May it not reside in a Polyphemus with one eyeball, or in an Argus with a hundred? May it not govern in the giant forms of the Titans, and direct the hundred hands of Briareus? But setting aside the ungainly creations of mythology, how many *probable* forms are there of beauty, and activity, and strength, which even the painter, the sculptor, and the poet could assign to the physical casket in which the diamond spirit may be enclosed; how many *possible* forms are there, beyond their invention, which eye hath not seen, nor the heart of man conceived?

But no less varied may be the functions which the citizens of the spheres have to discharge,—no less diversified their modes of life,—and no less singular

the localities in which they dwell. If this little world demands such duties from its occupants, and yields such varied pleasures in their discharge:—If the obligations of power, of wealth, of talent, and of charity to humanize our race, to unite them in one brotherhood of sympathy and love, and unfold to them the wonderful provisions for their benefit which have been made in the structure and preparation of their planetary home: If duties, so varied and numerous, have required thousands of years to ripen their fruit of gold, what inconceivable and countless functions may we not assign to that plurality of intellectual communities, which have been settled, or are about to settle in the celestial spheres? What deeds of heroism, moral, and perchance physical! What enterprises of philanthropy,—what achievements of genius may we not expect in empires so extensive, and in worlds so grand!

On a planet more magnificent than ours, may there not be a type of reason of which the intellect of Newton is the lowest degree? May there not be telescopes more penetrating, and microscopes more powerful than ours?—processes of induction more subtle, of analysis more searching, and of combination more profound? May not the problem of three bodies be solved there,—the enigma of the lumini-

ferous ether unriddled,—and the transcendentalisms of mind embalmed in the definitions and axioms and theorems of geometry? Chemistry may there have new elements, new gases, new acids, new alkalies, new earths and new metals;—geology, new rocks, new classes of cataclysms, and new periods of change; —and zoology, mineralogy, and botany, new orders and species, new forms of life, and new types of organization,—all demanding higher powers of reason, and leading to a warmer appreciation, and a higher knowledge of the ways and works of God. But whatever be the intellectual occupation of the inhabitants of the planets, who can doubt that it will be one of their objects to study and develop the material laws which are in operation around them, above them, beneath them, and beyond them in the skies?

Under what suns, in what climates, and in what habitations, these planetary races are to live and move, may be conjectured from the place which they occupy in the system, and from the phenomena which they exhibit when examined by the telescope. It may not be in cities exposed to the extremes of heat and cold,—nor in houses made with hands,—nor in the busy market-place,—nor in the noisy Forum,—nor in the solemn temple,—nor in the ark which rests upon the deep, that these feats of power and reason

are to be performed. The being of another mould may have his home in subterranean cities warmed by central fires,—or in crystal caves cooled by ocean tides,—or he may float with the Nereids upon the deep, or mount upon wings as eagles, or rise upon the pinions of the dove, that he may flee away and be at rest. Amid our meagre conceptions of the conditions of planetary life, we may gather some ideas from the existences around us. In the cities and dwellings and occupations of the world of *instinct* in our own planet, rude though they be, we may trace the lineaments of the cities and dwellings and occupations of *reason* in another.

In continuing the argument for a plurality of worlds, it would be a waste of time to enter into the same details respecting the analogy between the Earth and the other *four* superior planets of the system, as we have done with respect to Jupiter. In some, the analogies are more close than in others, but in all they are sufficiently numerous and powerful to command the assent of an unprejudiced mind.

In the three planets, superior to Jupiter, namely, *Saturn*, *Uranus*, and *Neptune*, the direct light and heat of the sun is greatly less than that which falls upon Jupiter, being inversely proportional to the squares of their distances from the centre of their

radiations ; but we have already seen, that in so far as vision and local temperature are concerned, the light of the sun may in these planets be as brilliant, and the temperature of the seasons as genial as they are upon our own Earth. An increased degree of sensibility in the nervous membrane of the eye, with an enlarged pupil, may give to light, geometrically feeble, a sufficient energy of sensation, while a different condition of their atmospheres, and a more ardent focus of internal heat, may maintain an agreeable temperature upon their surface.

The planet *Saturn*, encompassed with the extraordinary appendage of a ring, fitted to illuminate extensive portions of his surface, and encircled with eight moons lighting him in the sun's absence, and revolving round him in months varying from the length of *one* day up to *eighty* days, has always been an object of peculiar interest to the astronomer, and of wonder to the ordinary student of nature. The plane of the ring, which we have described in the preceding chapter, is parallel to the equator, and has inequalities like mountains on its surface. His eight satellites are placed at distances varying from 98,000 miles, the distance of the nearest from the planet, to nearly *two millions* of miles, the distance of the most remote ; and as the first five are nearer Saturn than

our moon is to the Earth, they will exhibit larger discs of light to the planet. Astronomers have not yet been able to measure their diameters, but if they are greatly larger than our moon, which is very probable, the firmament must exhibit a brilliant vault of azure, bespangled with large discs of light, with a variety of phases, and spanned with the brilliant arches of the planet's ring. As the nearest of these moons, which is called *Mimas*, performs its revolution in *twenty-two hours and a half*, its phases must change from the slenderest crescent to the state of half moon in the course of *five hours*, and as its disc (if it has the same real size as our moon) must appear *two and a half* times larger, the boundary between the light and dark hemisphere will be seen actually advancing upon the body of the satellite. For the same reason, the motion of this satellite among the stars will be more perceptible than the movement of our stars and planets from their rising to their setting, produced by the diurnal motion of the Earth.[1]

[1] The appearance of the system of rings from the surface of Saturn, and of the phenomena which they produce in eclipsing occasionally and temporarily the sun, the eight satellites, and other celestial bodies, was for the first time accurately described by Dr. Lardner in a memoir published in the twenty-second volume of the *Transactions of the Astronomical Society* for 1853.

With respect to the force of gravity upon the surface of Saturn, the analogy between it and the Earth is stronger than in the case of Jupiter. The density of Saturn is to that of the Earth as 24 to 100, or a little more than four times less, so that since the Earth is $5\frac{1}{2}$ times denser than water, the density of Saturn will be $1\frac{1}{3}$ths that of water. In like manner it may be shewn that Uranus and Neptune have nearly the same density as water, and if we make a similar estimate of the force of gravity upon the three superior planets, we shall find that in Saturn the force of gravity is a little greater than in the Earth, and in Uranus and Neptune a little less, so that human beings, like ourselves, would experience no inconvenience from the greater or less force of gravity on these planets, and plants and trees, and architectural

Dr. Lardner has there demonstrated "that the infinite skill of the great Architect of the Universe has not permitted that this stupendous annular appendage, the uses of which still remain undiscovered, should be the cause of such darkness and desolation to the inhabitants of the planet, and such an aggravation of the rigours of their fifteen years' winter, as it has been inferred to be from the reasonings of the eminent astronomers already named, (Bode, Herschel, and Madler,) as well as many others, who have either adopted their conclusions, or arrived at like inferences by other arguments." "In short," Dr. Lardner adds, "the ring has no such character as would deprive the planet *of any essential condition of habitability.*"—*Museum of Science and Art*, vol. i. p. 59.

structures, of the same character with our own, would have the same strength and permanence.

In consequence of the rotation of Saturn upon his axis in about 10½ hours, belts and streaks are seen upon his surface, produced, doubtless, as those in Jupiter, by equatorial currents like our trade winds. Variable masses of cloud diversify his surface, sometimes changing their place, and sometimes continuing so long in one position, that they reappear at one side of the planet's disc in the same place which they occupied five hours before when they disappeared on the other side of it.

In the two remote planets, *Uranus* and *Neptune*, the principal point of analogy with our Earth is, that they are lighted with moons,—Uranus with *six*, and Neptune with *one* or perhaps *two*, though we have no doubt that, like the other distant planets, he will be found to possess a greater number. The power of our best telescopes has not enabled astronomers to discover belts and clouds upon these two planets, and thus determine their daily motion. The oblate form of their discs, too, remains to be discovered; but notwithstanding the absence of these points of analogy, the very existence of such large globes of matter revolving round the sun, and lighted up with moons, cannot fail to satisfy the unprejudiced and inquiring

mind that they must have been created for some grand purpose worthy of their Maker. In the present state of our knowledge, it is impossible to conceive any other purpose than that of being the residence of animal and intellectual life.

There is one consideration in reference to the two remote planets, *Uranus* and *Neptune*, which some of our readers may regard as adding to the probability of their being worlds like our own. Some writers, or rather one, for we know of only one, have asserted that "however destitute planets, moons, and rings may be of inhabitants, they are at least vast scenes of God's presence, and of the activity with which He carries into effect everywhere the laws of nature, and that the glory of creation arises from its being not only the product, but the constant field of God's activity and thought, wisdom and power."[1] We shall not venture to ascertain how much more of God's glory is seen in the mere material structure of Saturn and his ring, and of Jupiter and his satellites, than it is in the minutest insect that lives but for an hour; nor shall we compare gigantic masses of self-luminous or opaque illuminated matter with the smaller organisms which are daily presented to us. We shall admit that the vulgar eye even is delighted

[1] *Of the Plurality of Worlds*: an Essay, p. 254.

with the sight of planets made gorgeous by the telescope,—that astronomers are entranced by the study of their movements and their perturbations, and that the useful art of navigation may derive some advantage from the eclipses of Jupiter's satellites. The poet, too, may rejoice in "the soft and tender beauty of the moon," and in the inspirations of the morning and the evening star. But where is the grandeur,—where the utility,—where the beauty,—where the poetry of the two almost invisible stars which usurp the celestial names of *Uranus* and *Neptune*, and which have been seen by none but a very few even of the cultivators of astronomy? The grand discoveries of Kepler, Newton, and Laplace, were made before these planets were known. They have, therefore, been of no use in establishing the physical laws of the universe. The seaman in the trackless ocean never seeks their guidance: to him they have not even the value of the polar star. They contribute nothing to the arts of terrestrial life: they neither light the traveller on his journey, nor mark by their feeble ray the happy hours which are consecrated to friendship and to love. They must, therefore, have been created for other and nobler ends,—to be the abodes of life and intelligence—the colossal temples where their Creator is recognised and worshipped,—

the remotest watch-towers of our system from which His works may be better studied, and His distant glories more readily descried.

From Jupiter and the planets beyond him, we now proceed to the examination of Mars, Venus, and Mercury, and here we shall find analogies more or less numerous and striking with those of our own Earth. In this group of planets no moon or satellite has yet been discovered, and it is probable that none exists. An atmosphere of great height and of a peculiar constitution, reflecting on the planet the light of the sun many hours after he has set, might in all of them supply the place of a moon. The density of Mars and Venus is very nearly the same as that of the Earth, the density of the former being 0·25, and that of the latter 0·82, while the density of Mercury is a little greater, amounting to 1·12. As the diameter of Venus is nearly equal to that of the Earth, the force of gravity upon its surface will be almost exactly the same; and in Mars and Mercury, whose diameters are only about one half that of the Earth, the weight of bodies will be about one half of what they would be if placed upon our own globe.

In Mars, Venus, and Mercury, the length of the day is almost exactly twenty-four hours, the same as

that of the Earth,[1] and in many other points the analogy with our globe is very striking. Continents, and oceans, and green savannahs, have been observed upon Mars, and the snow of his polar regions has been seen to disappear with the heat of summer. In Venus and Mercury their surface is variegated with mountain chains of great elevation, and but for the brilliancy of their discs, and the clouds which envelop them, the telescope would have discovered to us more minute details upon their surface.

The planets of this inferior group are surrounded with atmospheres like our Earth. We actually see the clouds floating in the atmosphere of Mars, and there is the appearance of land and water on his disc. Venus and Mercury are surrounded with the same medium essential to life, and in Venus astronomers have even observed the morning and the evening twilight. These atmospheres are doubtless the means of tempering the great heat which Venus and Mercury receive from the sun; and the same purpose may be answered by the absence of that

[1] The mean of the length of the day in these four planets, is within less than a minute of twenty-four hours. The days of Mercury, Venus, the Earth, and Mars, are respectively $24^h\ 5^m$; $23^h\ 21^m$; $24^h\ 7^m$, and $24^h\ 7^m$; the mean of which is $24^h\ 0^m\ 45^s$.

internal heat which exists in the Earth, and which may be used to increase the temperature of the remoter planets. The intense light which Venus and Mercury receive from the sun may be adducec as an objection to the existence, upon these planets, of inhabitants like ourselves; but this objection is at once removed by the consideration that this intense light may be completely moderated either by a very small pupil, or by a diminished sensibility of the retina, or by a combination of both.

Such are the numerous analogies which subsist between our Earth and Mars, Venus and Mercury. They afford, as a popular writer observes, "the highest degree of probability, not to say moral certainty, to the conclusion, that these three planets which, with the Earth, revolve nearest to the Sun, are, like the Earth, appropriated by the Omnipotent Creator and Ruler of the Universe to races very closely resembling, if not absolutely identical with those with which the Earth is peopled."[1] After concluding his examination of the four exterior planets, Jupiter, Saturn, Uranus, and Neptune, the same able and candid writer closes his elaborate chapter in these words:—

"We have thus presented the reader with a brief

[1] Dr. Lardner's *Museum of Science and Art*, vol. i, p. 23.

and rapid sketch of the circumstances attending the two chief groups of globes which compose the Solar system, and have explained the discoveries and striking analogies, *which taken together amount to a demonstration*, that in the economy of the material universe these globes must subserve the same purposes as the Earth, and *must be the dwellings of tribes of organized creatures* having a corresponding analogy to those which inhabit the Earth.

"The differences of organization and character which would be suggested as probable or necessary by the different distances of the several planets from the common source of light and heat, and the consequent differences of intensity of these physical agencies upon them, by the different weights of bodies on their surfaces, owing to the different intensities of their attractions on such bodies, by the different intervals which mark the alternation of light and darkness, are not more than are seen to prevail among the organized tribes, animal and vegetable, which inhabit different regions of the earth. The animals and plants of the tropical zones differ in general from those of the temperate and the polar zones, and even in the same zone we find different tribes of organized creatures flourish at different elevations above the level of the sea.

There is nothing more wonderful than this in the varieties of organization suggested by the various physical conditions by which the planets are affected."[1]

To this opinion of a mathematician and a natural philosopher, who has studied more than any preceding writer the analogies between the Earth and the other planets, we may add that of the most distinguished naturalist and anatomist of the present day, who speaks in an authoritative tone as representing the cultivators of that department of science which he has enriched with such important discoveries. "We have been accustomed," says Professor Owen,[2] "to regard the vertebrate animals as being characterized by the limitation of their limbs to two pairs, and it is true that no more diverging appendages are developed for station, locomotion, and manipulation. But the rudiments of many more pairs are present in many species. *And though they may never be developed as such in this planet, it is quite conceivable that certain of them may be so developed, if the vertebrate type should be that on which any of the inhabitants of other planets of our system are organized.*

"The conceivable modifications of the vertebrate

[1] Dr. Lardner's *Museum of Science and Art*, vol. i. p. 63.
[2] *On the Nature of Limbs.* London, 1849, pp. 83, 84.

archetype are very far from being exhausted by any of the forms that now inhabit the Earth, or that are known to have existed here at any period.

"*The naturalist and anatomist, in digesting the knowledge which the astronomer has been able to furnish regarding the planets and the mechanism of the satellites for illuminating the night season of the distant orbs that revolve round one common sun, can hardly avoid speculating on the organic mechanism that may exist to profit by such sources of light, and which* MUST EXIST *if the only conceivable purpose of these beneficent arrangements is to be fulfilled.* But the laws of light, as of gravitation, being the same in *Jupiter* as here, the eyes of such creatures as may disport in the soft reflected beams of its moons will probably be organized on the same dioptric principles as those of the animals of a like grade of organization on this *earth.* And the inference as to the possibility of the vertebrate type being the basis of the organization of *some of the inhabitants of other planets,* will not appear so hazardous when it is remembered that the orbits or protective cavities of the eyes of the vertebrata of this planet are constructed of modified vertebræ. Our thoughts are free to soar as far as any *legitimate analogy* may seem to guide them rightly on the boundless ocean of unknown truth. And if censure

be merited for here indulging, even for a moment, in pure speculation, it may perhaps be disarmed by the reflection that the discovery of the vertebrate archetype could not fail to suggest to the anatomist many possible modifications of it beyond those that we know to have been realized in *this little orb of ours.*"

These important and original views arose from the recognition of what he thought rudiments of limbs which had never been developed, in so far as yet known, to functional importance in any terrene vertebrate, and we believe that no naturalist or anatomist, except himself, had arrived at any distinct notion of the common pattern of the vertebrate skeleton, especially in regard to the nature of limbs, leading to a recognition of the rudiments of limbs in the thorax of fishes, crocodiles, and birds.

But valuable as this discovery must be regarded by the philosophical naturalist, its application to the possible forms of life in other planets possesses a more general interest, and forms an entirely new, and we think, irresistible argument for a plurality of worlds.

"The insect forms," says Professor Owen, in an unpublished memorandum, "with which the Creator has associated instincts that simulate closely our

boasted reason are so inconceivably different from our own or any vertebrate organization, as to lead any one conscious of the extremely narrow field to which his observation of life-phenomena is here restricted, to deem it highly probable that the forms of organization endowed with physical powers akin to our own in other planets, may nevertheless be very different from ours, and be as admirably adapted to the media of existence in those planets. As a vast variety of organizations do exist in *one* planet to manifest the riches of creative resources, and amongst that variety a species capable of conceiving how very far these resources are from having been exhausted. Since, moreover, it has been given to that species, in God's good time, to know the subordinate character of the globe it inhabits amongst the stars of heaven, a conception of the probability of analogous globes being analogous seats of equal variety of creative adaptations is inevitable. The grounds of belief vary with the probability of a proposition: If nothing better than analogy can be had,—on analogy will belief be based."

In referring to the doctrine of Plato respecting ideal archetypes, as thus revived by Professor Owen, the author of the *Essay of a Plurality of*

worlds pays the following just compliment to this eminent anatomist:—"If a mere metaphysician," says he, "were to attempt to revive this mode of expressing the doctrine, probably his speculations would be disregarded, or treated as a pedantic resuscitation of obsolete Platonic dreams, but the adoption of such language must needs be received in a very different manner when it proceeds from a great discoverer in the field of natural knowledge: when it is, as it were, forced upon *him* as the obvious and appropriate expression of the result of the most profound and comprehensive researches into the frame of the whole animal creation. The recent works of Mr. Owen, and especially one work *On the Nature of Limbs*, are full of the most energetic and striking passages, inculcating the doctrine which we have been endeavouring to maintain. We may take the liberty of enriching our pages with one passage bearing upon the present part of the subject.

"'If the world were made by an antecedent mind or understanding, that is, by a Deity, then there must needs be an Idea and Exemplar of the whole world before it was made, and consequently, actual knowledge both in the order of Time and Nature, before Things. But conceiving of knowledge as it

was got by their own finite minds, and ignorant of any evidence of an ideal archetype for the world or any part of it, they (the Democritic philosophers who denied a Divine Creative Mind) affirmed that there was none, and concluded that there could be no knowledge or mind before the world was, as its cause.'"

Before we read this passage in Professor Owen's work *On Limbs*, from which our essayist does not quote it,[1] for reasons which may be conjectured, we never doubted that the accomplished professor did not believe in a plurality of worlds. Upon turning, however, to the volume itself, we found the beautiful passage which we have quoted in direct support of this great doctrine, which we may truly say, in the words of the essayist, "*proceeds from a great discoverer in the field of natural knowledge, and which was forced upon him* (Professor Owen) *as the obvious and appropriate expression of the result of the most profound and comprehensive researches into the frame of the whole animal creation.*"

But not only has the essayist dealt thus unfairly with his readers, he has treated Professor Owen in the same manner, by ascribing to him the first

[1] The quotation may be from Professor Owen's other works referred to by the essayist,—his work, for example, *On the Archetype of the Vertebrate Skeleton.*

half of the preceding quotation, which the Professor quotes from "the learned Cudworth" in his own words, and which Cudworth gives as the opinion of "*the Democritic Atheists!*"

The observations of Professor Owen on ideal archetypes throw a real light on the subject of a plurality of worlds. If there be an ideal exemplar or archetype of vertebrate animals, and if the conceivable modifications of that archetype are far from being exhausted either in the animal forms which now inhabit the earth, or in the fossil remains of its primæval tenants, it is no idle speculation to suppose that the modifications may be developed in the vertebrate animals of other planets. We have a reason, therefore, besides those of analogy and congruity, to believe in the existence of beings both intellectual and animal in the other regions of space. And as there must be an exemplar of intellectual as well as of physical man, may we not equally expect, in the upper spheres, modifications of mind which have not been exhibited in the terrestrial races? If the rudimentary wing of man be expanded into the soaring pinion of the eagle, may not those mental powers which are only rudimentary here, and which fail in grasping the infinite and the eternal, expand themselves in another planet, and approximate to

that divine intelligence of which they are here but a feeble emanation?

Under the influence of such views, may we not conceive also the archetype of a world, the rudiments of which, imperfectly developed in our own globe, may have all its modifications exhausted in the planetary and sidereal domains? The uniformity in the general design of the bodies of animals, which Sir Isaac Newton compares with that "wonderful uniformity of the planetary system, which is the effect of choice," being thus compatible with an almost infinite diversity of parts, there may be the same numerous deviations from the archetype in the planetary world. "It may be allowed," says Sir Isaac Newton, "that God is able to create particles of matter of several sizes and figures, and in several proportions to space, and perhaps of different densities and forces, and thereby to vary the laws of Nature, and *make worlds of several sorts in several parts of the universe.*"[1] If all the structures of created things are

"Parts and proportions of a wondrous whole,"

that *whole* is the sidereal universe, and those parts and proportions are the inhabited planets, satellites, and suns of which it is composed.

[1] *Optics*, edit. 1721, pp. 378, 379.

CHAPTER V.

THE SUN, MOON, AND SATELLITES.

SO strong has been the belief that the Sun cannot be a habitable world, that a scientific gentleman[1] was pronounced by his medical attendant to be insane, because he had sent a paper to the Royal Society, in which he maintained "that the light of the sun proceeds from a dense and universal aurora which may afford ample light to the inhabitants of the surface beneath, and yet be at such a distance aloft, as not to annoy them;"—that "vegetation may obtain there as well as with us,"—that "there may be water and dry land there, hills and dales, rain, and fair weather,"—and that "as the light and the seasons must be eternal," the "sun

[1] This gentleman was a Dr. Elliott, who was tried at the Old Bailey for shooting Miss Boydell. Her medical attendant was Dr. Simmons, through whom he sent the paper for the Royal Society, and who referred the Court to the passage we have given as a proof of insanity. See *Edinburgh Encyclopædia*, Art. Astronomy, vol. ii. p. 616, or *Gentleman's Magazine* for 1787, p. 636.

may easily be conceived to be by far the most blissful habitation of the whole system." About half a century before this opinion was given by Dr. Elliott, a pious and distinguished individual, Lord President Forbes of Culloden, stated it as his opinion, that if the planets were inhabited, "the inhabitants must be of a texture very different from those of the earth," and that "we cannot deem it impossible that beings may have been made, fit to reside, to act, and to think *in the very centre, as well as on the surface of the sun.*"[1] And in less than ten years after this apparently extravagant notion had been considered a proof of insanity, it was maintained by Sir William Herschel as a rational and probable opinion, which might be deduced from his own observations on the structure of the sun.

It is by no means necessary that those who believe in a plurality of worlds within the limits of our own system, should adopt the opinion that the Sun which lights it, and the many satellites which light the primary planets, should be inhabited worlds. They form an entirely different class of bodies, and the arguments employed to shew that they maybe inhabited are of a different nature from those analogies

[1] *Reflections on the sources of Incredulity with regard to Religion*, p. 3. Edinburgh, 1750.

which so strongly apply to the primary planets. The Sun has a great function to perform in controlling the movements of the whole system. It is the mainspring of the great planetary chronometers, without which they would stop, and rush into destructive collision. It is the lamp which yields them the light without which life would perish. It is the furnace which supplies the fuel without which organic nature would be destroyed. Created for such noble purposes, we are led by no analogy to assign to it an additional function. The very same remark may be applied to our moon, and to all the satellites of the system. They are the domestic lamps which light the primary planets in the absence of the sun, and all of them, as well as our own, may exercise the other office of producing the tides of their oceans. It is quite otherwise with the primary planets: They have no conceivable function to perform but that of supporting inhabitants, unless we give them the additional one which they are all fit for performing, and which they perform so well, of becoming gigantic lamps to their satellites; and if we invest them with this function, we obtain an argument in favour of the satellites themselves being inhabited.

We are willing therefore to admit that analogy

would fail us, were we to attempt by its processes to people the sun and the satellites with inhabitants. But analogy is not our only guide in such inquiries. The creations of the material world, whether they be of colossal or atomic magnitude, may have various and apparently contradictory purposes to answer; and when we find that other purposes, not cognizable by our senses, or not demonstrable by our reason, may be promoted by such objects, we cannot resist the admission that such additional objects may have been contemplated in their creation. The great masses of ironstone in our earth, while they are a necessary part of its framework, and are intended mainly to supply man with the tools of civilisation, may have the secondary or the tertiary purpose of giving life to the needle of the compass, or of contributing to those great electrical and magnetical arrangements which exist on our globe. Though the sun then and the satellites are primarily intended for the great purposes which they so obviously subserve, it is not unreasonable to suppose that they may also be the seats of life and intelligence.

After a skilful examination of the solar spots, Sir William Herschel has made it highly probable, if not certain, that the light of the sun issues from an outer stratum of self-luminous or phosphoric

clouds, beneath which there is a second stratum of clouds of inferior brightness, which is intended to protect the solid and opaque body of the sun from the intense brilliancy and heat of the luminous clouds. In measuring photometrically, the light of these three different structures, he found that the light reflected *outwards* by the clouds of the inferior stratum, was equal to 469 rays out of a 1,000, or less than one-half of the light of the outer stratum; and that the light reflected by the opaque body of the sun below was only seven rays out of a 1,000. Hence he concluded that the outer stratum of self-luminous or phosphoric clouds was the region of that light and heat which are transmitted to the remotest part of the system; while the inferior stratum, which is obviously of a different character from the other, is intended to protect the inhabitants of the sun from the blaze of the stupendous furnace which encloses them. In confirmation of these views, the faint illumination,—the *seven rays out of a thousand,* is a proof that the light of the outer stratum, and consequently its heat, must be extremely small upon the dark body of the luminary which we see through what are called the solar spots, which are now universally admitted to be openings in the luminous stratum, and not opaque scoriæ floating on its surface.

It is curious to observe, how the conjectures in one science are sometimes converted into truths by the discoveries in another. Sir William Herschel, as we have seen, has stated it as the result of many observations, that the light of the sun does not proceed, as was almost universally believed, from a solid or liquid mass in a state of incandescence, or white heat, and the fact has been demonstrated by means of a beautiful optical discovery of M. Arago: —When a solid mass becomes luminous by being raised to a red or white heat, the rays which emanate from it in every direction do not proceed only from its outer superficies. They are radiated like those of heat from an infinite number of material points below the surface, and extending to a certain small depth. The rays which traverse this thin luminous film, have been found by M. Arago to be polarized, whereas, had they proceeded from an envelope of flame, they would not have exhibited this remarkable property. Now, M. Arago has also discovered that the rays which issue obliquely from the sun's surface are not polarized, and hence he is authorized to draw the conclusion confirming Sir W. Herschel's opinion, that the light of the sun issues from a gaseous envelope of flame, or self-luminous matter.

With this important result before us, we approach the question of the habitability of the sun, with the certain knowledge that the sun is not a red-hot globe, but that its nucleus is a solid opaque mass receiving very little light and heat from its luminous atmosphere. Sir William commences his argument by inquiring into the probability of the moon being inhabited.

"The moon," he says, "is a secondary planet, of a considerable size, the surface of which is diversified like that of the earth, by mountains and valleys. Its situation with respect to the sun is much like that of the earth, and, by a rotation upon its axis, it enjoys an agreeable variety of seasons, and of day and night. To the moon our globe will appear to be a very capital satellite, undergoing the same regular changes of illumination as the moon does to the earth. The sun, the planets, and the starry constellations of the heavens, will rise and set there as they do here, and heavy bodies will fall on the moon as they do on the earth. There seems only to be wanting, in order to complete the analogy, that it should be inhabited like the earth.

"To this it may be objected, that we perceive no large seas in the moon; that its atmosphere (the existence of which has been doubted by many) is

extremely rare, and unfit for the purposes of animal life; that its climates, its seasons, and the length of its days, totally differ from ours; that without dense clouds (which the moon has not) there can be no rain—perhaps no rivers, no lakes. In short, that notwithstanding the similarity which has been pointed out, there seems to be a decided difference in the two planets we have compared.

"My answer to this will be, that that very difference which is now objected will rather strengthen the force of my argument than lessen its value: we find even upon our globe, that there is the most striking difference in the situation of the creatures that live upon it. While man walks upon the ground, the birds fly in the air, and fishes swim in water, we can certainly not object to the convenience afforded by the moon, if those that are to inhabit its regions are fitted to their conditions as well as we on this globe are to ours. An absolute or total sameness seems rather to denote imperfections such as nature never exposes to our view; and on this account, *I believe the analogies that have been mentioned sufficient to establish the high probability of the moon's being inhabited like the earth.*"

Sir William Herschel proceeds to put the argument in another shape. He supposes that the in-

habitants of the moon, and the other satellites, if they do exist, are of opinion that the Earth and the other primary planets are of no other use but as lamps, and "attractive centres to direct their revolution round the sun;" and he then asks, "if we ought not to condemn their ignorance as proceeding from want of attention and proper reflection?"

From these considerations Sir William thinks that the inhabitants of the planets ought to be wiser than we have supposed those of their satellites to be. "From experience," he adds, "we can affirm, that the performance of the most salutary offices to inferior planets is not inconsistent with the dignity of superior purposes; and in consequence of such analogical reasonings, assisted by telescopic views which plainly favour the same opinion, *we need not hesitate to admit that the sun is richly stored with inhabitants.*"

From the phenomena of variable stars which Sir William supposes to arise from their having spots, and revolving about an axis, he considers it as hardly admitting of a doubt that the fixed stars are suns; and he comes to the conclusion, that "if stars are suns, and suns inhabitable, we see at once what an extensive field of animation opens itself to our view." "It is true," he adds, "that analogy

may induce us to conclude, that since stars appear to be suns, and suns, according to the common opinion, are bodies that serve to enlighten, warm, and sustain a system of planets, we may have an idea of numberless globes that serve for the habitation of living creatures. But if these suns themselves are primary planets, we may see some thousands of them with our own eyes, and millions by the help of telescopes; when, at the same time, the same analogical reasoning still remains in full force, with regard to the planets which these suns may support."[1]

The opinion of so distinguished an astronomer as Sir William Herschel, cannot fail to have much weight on a subject like this; but though we are desirous of strengthening rather than of controverting his arguments, there are yet some difficulties to be removed, and some additional analogies to be adduced, before the mind can admit the startling proposition, that the sun, moon, and all the satellites, are inhabited spheres. We may, indeed, reject this opinion, and yet believe implicitly in a plurality of worlds.

In giving an account of these views of Sir William

[1] *Philosophical Transactions*, 1795, pp. 65-69; and 1801, p. 296.

Herschel, Dr. Thomas Young[1] has remarked that "no clouds, however dense, could impede the transmission of the sun's heat to the parts below;" and that "if every other circumstance permitted *human* beings to reside upon it, their own weight would present an insuperable difficulty, since it would become nearly thirty times as great as upon the surface of the earth, a man of moderate dimensions weighing above *two tons*." The first of these difficulties has certainly no weight. If the heat of the sun's rays is proportional to its light, which it must be if it is a flame, the darkness of the sun's nucleus becomes a measure of its coolness. Even a human being might live and breathe upon the solid nucleus under the heat which is indicated by *seven rays out of a thousand*. The second objection is equally inapplicable, because Sir William has never asserted, and never did believe, that the children of the sun were to be *human* beings, but, on the contrary, creatures "fitted to their condition as well as we on this globe are to ours."

It has been stated as an objection to the probability of the sun's being inhabited, that the whole firmament would be hid by the double atmosphere with which he is surrounded, and that the solar

[1] *Elements of Natural Philosophy*. vol. i., pp. 501, 502.

inhabitants would be excluded from all knowledge of the planets which he guides, and of the sidereal universe of which he is a part. This, however, is not strictly true. The planets and stars would be seen distinctly through the numerous openings in the solar atmosphere, and as the surface of the nucleus, which we suppose to be inhabited, is comparatively near to these openings, large portions of the heavens would be exposed to view during the rotation of the sun. In many parts of our own globe weeks pass away without our seeing the sun or the stars, and it cannot be doubted that the inhabitants of the sun might study astronomy through the casual openings in the luminous cupola which encloses them.

The probability of the sun being inhabited is doubtless greatly increased by the simple consideration of its enormous size. Admitting, with Sir William Herschel, that the sun may have a temperature adapted even for human constitutions, it is difficult to believe that a globe of such magnificence, 882,000 miles in diameter, upwards of one hundred and eleven times the size of our earth, and 1,384,472 times its bulk, should occupy so distinguished a place without intelligent beings to study and admire the grand arrangements which exist

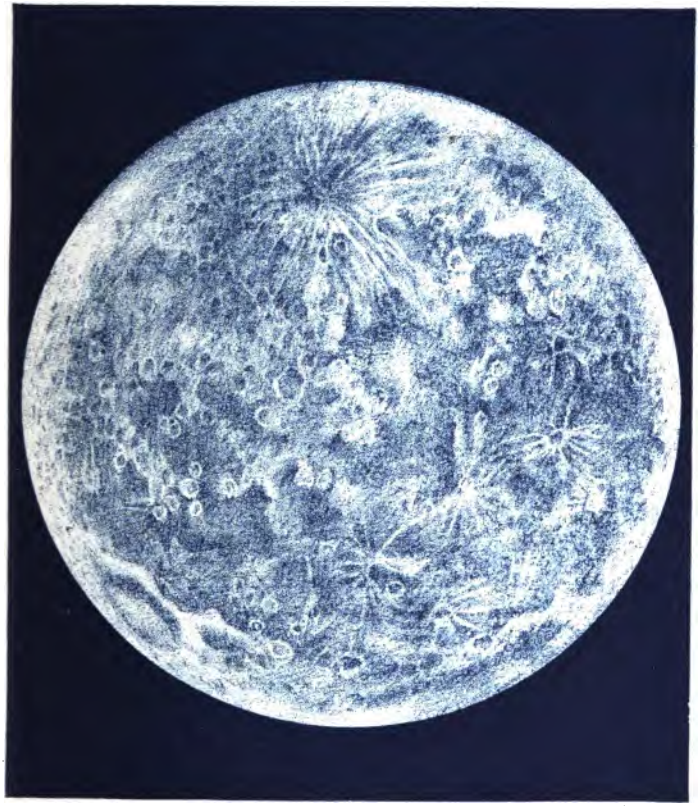
around them; and it would be still more difficult to believe, if it is inhabited, that a domain so extensive, so blessed with perpetual light, is not occupied by the highest orders of intelligence. In the material world with which we are connected, life everywhere meets our eye. It is virtually almost a property of matter, and therefore to conceive huge masses of matter, that are warmed and heated, to be destitute of life, is to do violence to our strongest convictions. Those who believe life to be the result of second causes, must believe in its universal diffusion; and those who have the conviction, that into every living thing the Almighty must breathe its breath, will find it difficult to believe that the life which swarms around him on the earth, the ocean, and the air, of his own planet, has been denied to the other bodies of the system. Universal life upon universal matter is an idea to which the mind instinctively clings. Kingdoms without kings and subjects—continents without cities—cities without citizens—houses without families—ships without crews, and railway trains without passengers, are contingencies as probable as solar systems without planets, or planets without inhabitants.

To the arguments so well stated by Sir William Herschel in favour of his opinion that the moon is

inhabited, some important considerations may be added. The moon certainly has neither clouds nor seas; but this is no reason why she may not have an atmosphere, and a precipitation of moisture upon her surface, sufficient for the support of vegetable life. The moon may have streams or even rivers that lose themselves, as some of our own do, either in the dry ground, or in subterranean cavities; or they may be lost by absorption or evaporation, as in the dry saline deserts of Australia. There may be springs too, and wells sufficient for the use of man; and yet the evaporation from the water thus diffused may be insufficient for the formation of clouds, and consequently for the production of rain. The air may be charged to such a small extent with aqueous vapour, that it descends only in gentle dews, to be absorbed by vegetation, and again returned to the atmosphere. Even in our own planet there are regions of some extent where rain never falls,[1] and where the aqueous vapour in the atmosphere descends only in refreshing dews.

Although Sir John Herschel has stated that there are no decisive indications of an atmosphere in the moon, yet he has given the following very ingenious theory of her climate, which implies the existence

[1] See Johnston's *Physical Atlas*, Plate III. of Meteorology.



THE FULL MOON

of an atmosphere, and even of *running water*. "The climate of the moon," says he, "must be very extraordinary; the alternations being that of unmitigated and burning sunshine fiercer than an equatorial noon continued for a whole fortnight, and the keenest severity of frost, far exceeding that of our polar winters for an equal time. Such a disposition of things must produce a constant transfer of whatever moisture may exist on its surface, from the point beneath the sun to that opposite, by distillation *in vacuo*, after the manner of the little instrument called a *cryophorus*. The consequence must be absolute aridity below the vertical sun, constant accretion of hoar frost in the opposite region, and perhaps *a narrow zone of running water* at the borders of the enlightened hemisphere. It is possible, then, that evaporation on the one hand, and condensation on the other, may, to a certain extent, preserve an equilibrium of temperature, and mitigate the extreme severity of both climates; but this process, which would imply the continual generation and destruction *of an atmosphere of aqueous vapour*, must, in conformity with what has been said above of a lunar atmosphere, be confined within very narrow limits."

In some of the principal craters, Sir John Herschel

tells us "that there are *decisive marks of volcanic stratification*, arising from successive deposits of *ejected matter*, and evident indications of lava currents;" and he admits that "there are large regions perfectly level, and apparently of *a decided alluvial character*,"—conditions of the moon's surface, which demonstrate that there has been an atmosphere to promote combustion, and water to produce an alluvion. We do not understand how modern writers on astronomy have overlooked so completely the many arguments for the existence of an atmosphere in the moon, which have been almost universally admitted. Facts observed a century ago by astronomers distinguished for their accuracy, are not less important because they have not been observed by their successors. Volcanoes may have been seen in the moon in the 18th century, though they have not been observed in the 19th; and a decided indication of atmospheric action to-day, will not be disproved by its invisibility to-morrow.

That volcanoes or burning regions have been observed in the dark portion of the moon's disc, cannot be doubted. In 1772, Beccaria, and in 1778, Ulloa, observed a bright white spot on the moon's disc. The spot observed by Ulloa and other three observers, resembled an opening in the

moon; but Beccaria was of opinion that this spot, as well as the one seen by himself, was the flame of a burning mountain. Various other persons have seen phenomena of the same kind; but all doubt upon this subject was removed when so accurate an observer as Sir William Herschel announced the discovery of volcanoes in the moon. On the 4th May 1783, he perceived a luminous spot in the obscure part of the moon, and *two mountains which were formed from the 4th to the 13th of May!* On the 19th April 1787, he perceived "*three volcanoes in different places of the dark part of the moon.* Two of them were already nearly extinct, or otherwise in a state going to break out, which perhaps may be decided next lunation. The third shews *an actual eruption of fire*, or luminous matter." On the following day the volcano was burning with greater violence than the night before, and he found it equal to twice the size of the second satellite of Jupiter, and consequently, above three miles in diameter. Sir William observed that the eruption resembled a piece of burning charcoal. These volcanic fires were observed also by Cassini, Captain Kater, Dr. Maskelyne, and more recently by Admiral Smyth, who justly remarks that "they settle the contested point of the existence of a lunar atmo-

sphere." We have been surprised at the facility with which Dr. Lardner, Mr. Nasmyth, and Mr. Crampton, have given up the idea of an atmosphere in the moon, wihout assigning anything like a valid reason for their opinion. Maintaining, as they do, that the moon's surface is covered with the craters of "countless thousands of volcanoes," and knowing that in the opinion of all philosophers, volcanoes are produced by the elastic force of gases and vapours, which eject the melted lava, and themselves issue, along with it, into the ethereal space, how can they suppose that these gases are again destroyed, and do not, as they must, form an atmosphere round the planet? Every planet whose surface has been perforated with volcanic vents, must necessarily have an atmosphere.

M. De La Place regards the moon as having an atmosphere more attenuated than what is called the vacuum in an air-pump; and MM. Mädler[1] and Beer, who have studied the moon's surface more diligently than any of their predecessors or contemporaries, have arrived at the conclusion that she has an atmosphere,—that her small mass prevents her from retaining around her an extensive portion of it, and that the conflicting observations on the

[1] Der Mond, p. 152. Berlin, 1837.

form of stars and planets eclipsed by the moon, may arise from the influence of local causes in "dimming or condensing" her highly rarefied atmosphere.

But, independent of these considerations, we maintain *that every planet and satellite in the Solar system must have an atmosphere.* Matter, without water and gaseous elements, either as adhering substances or as essential parts of it, is unknown to science. The water of crystallization of lunar matter must have been set free during the agency of volcanic forces, and have taken its place round the body of the Moon. Another origin of the atmospheres of satellites is found in the indefinite extension of the atmospheres of their primaries. Science has not yet limited the extent of the elastic forces of gaseous bodies, and the failure of Dr. Wollaston, in his elaborate attempt to prove the finite extent of an atmosphere, leaves our position in its original force.

We believe that the whole staff of living astronomers may be arranged into *four* classes :—

1. Those who believe that the *zodiacal light*, as it is called, is the Sun's atmosphere.
2. Those who believe that the tails of Comets bring vapour into our system, and leave portions of it behind.

3. Those who believe in the Nebular Theory; and lastly,
4. The single individual, the Essayist, who believes that the *Earth and Moon* occupy that middle part of the system, "where *moist and dry* is possible," or, as he otherwise expresses it, "between the hot and fiery haze on the one side, and the cold and watery vapours on the other."

Of these four classes each and all of them are bound by their opinions to believe in a lunar atmosphere.

1. The Zodiacal light, the Sun's atmosphere, extends beyond Venus, and, as Sir John Herschel remarks, "attains *nearly, perhaps quite*, to the orbit of the Earth," that is, its luminous part; but it is obvious, that if this part is visible as far as our Earth, the weaker part of this atmosphere reflecting light too faintly to be appreciated by us, when our retina is affected with other light, must extend much farther. But even if this is not the case, it must certainly reach the Moon when in her perihelion, or 240,000 miles nearer the Sun than the Earth. Now, though Sir John Herschel does not consider this dense and gaseous medium, as properly speaking an atmosphere revolving with the Sun, yet

he considers it as a material resisting mass, "loaded perhaps with the actual materials of the tails of millions of comets, of which they have been stripped in their successive perihelion passages." Hence it follows, that the moon must draw around her, as an atmosphere of her own, a portion of this material mass, and even if she were not placed in it, she must have received no small portion of it when diffused in her vicinity, in the form of comets' tails millions of miles in extent.

2. Those who do not believe in a Solar atmosphere extending to the Moon, but believe in the gaseous and vaporous character of the tails of millions of comets passing through our system in all directions, must admit that a portion of such atmospheric elements could not be withheld from the Moon. The Comet of Lexell, which passed among Jupiter's satellites, must have paid to them for its passage a portion of its tail.

3. Those who believe in the Nebular Theory consider it as certain that our Earth derived its solid matter and its atmosphere from a ring thrown from the Solar atmosphere, which afterwards contracted into a solid terraqueous sphere, from which the Moon was thrown off by the same process. The Moon, therefore, must necessarily have carried off

water and air from the watery and aerial parts of the Earth, and must have an atmosphere.

4. The Essayist, who believes in the nebular hypothesis, must, therefore, admit an atmosphere in the Moon; but he is doubly bound to admit it, and cannot escape from the admission, when he adds to the nebular theory the hypothesis of his own that the watery parts of the Sun's atmosphere were "driven into the outer orbs," the fiery parts reserved for Mercury and Venus; and the Earth, and the Moon of course, placed between the wet and the dry "lumps" of the solar system, with all that coolness and moisture which is essential to organic life. In its passage outwards the Moon could not have escaped from the watery current in which it lay, even if it had, at that time, been divorced from its parent Earth.

But the Essayist is committed to a belief in a lunar atmosphere by another hypothesis in which he has indulged. Our readers may perhaps know that about the 13th of November and the 10th of August a much greater number of shooting or falling stars occur than at any other time of the year. The Essayist considers these shooting stars as "specks of nebulæ," and outriders of the zodiacal light, (the sun's atmosphere,) portions of it which

being external to the permanently nebulous central mass have broken into patches and are seen as stars for the moment we are near to them,—that is, portions of a nebulous mass moist and dry. Now, as the Earth *with the Moon* passes through this nebular region twice a year, the Moon must carry off and surround herself with an atmosphere of this matter. Nay, we go much further in following out these views. Shooting stars fall at all seasons of the year, though they fall in greater numbers in August and November than in any other month. From observations made in Paris by M. Coulvier Gravier, from July 1841 to February 1845, it appears that in each of the first six months of the year the hourly mean number of shooting stars was nearly 4·00, more accurately 3·6, while in July, August, and September, the number was 7½, and in October, November, and December, nearly 9. It is evident, therefore, that in every part of the Earth's orbit the Earth and Moon are involved in the nebular matter, (moist and dry), which form the shooting stars. The Moon consequently, if the speculation of the Essayist be correct, must be surrounded with an atmosphere of the vaporous matter through which she continually moves.

Although Sir John Herschel broadly asserts, that

in the occultations of stars and planets by the moon, there is no appearance whatever of an atmosphere; yet we have many facts which stand in direct opposition to this statement. Cassini assures us, that he *frequently* observed the *circular* figure of Jupiter, Saturn, and the fixed stars changed into an elliptical one, when they approached either the dark or the illuminated limb of the moon. Mr. Dunn saw Saturn and his ring emerge from the moon's limb like a comet; Admiral Smyth has observed not only a diminution of the star's brightness, but an apparent projection of the star on the moon's disc at the instant of contact; and M. Schroeter of Lilienthal, with fine telescopes, observed "several obscurations and returning serenity, eruptions, and other changes in the lunar atmosphere." The same astronomer discovered the twilight of the moon at the extremity of its cusps, and he found by measurement, that the inferior or more dense part of the moon's atmosphere was not above 1,500 feet, or the *third* of a mile high, while the height of the atmosphere where it could affect the brightness of a fixed star, is not above 5,742 feet, or not much more than a mile. Hence we see the reason why changes are only occasionally produced upon stars occulted by the moon. *Her atmosphere is greatly lower than her*

mountains. When the stars, therefore, enter, or emerge from, behind mountains higher than her atmosphere, they are not affected by refraction; and when behind mountains or level plains lower than her atmosphere, they are affected by the refraction of the superincumbent air.

It is evident, therefore, from all these facts, that in her volcanoes, active and extinct, in her twilight, and in her action upon immerging and emerging stars, by which they have been frequently seen projected on her disc, the moon exhibits such proofs of an atmosphere, that we have a new ground from analogy for believing that she either has inhabitants, or is in a state of preparation for receiving them.

Had the moon been destined to be merely a lamp to our earth, there was no occasion to variegate its surface with lofty mountains and valleys, and deep cavities, and extinct volcanoes, and cover it with large patches of matter, that reflect different quantities of light of different tints, and give parts of its surface, such as the *Mare Serenitatis*, *Mare Crisium*, and *Mare Humorum*, the appearance of green fields, continents, and seas.[1] *It would have been a better*

[1] Dr. Olbers was of opinion that the surface of the moon exhibited signs of vegetation, and that she was inhabited.

lamp had it been a smooth sphere of lime or of chalk, and it would have performed equally well its other function of producing the tides in our ocean. The existence of extinct volcanoes too, the upheaval of lofty mountains, are proofs of a *progression in its physical history*—of a preparation, perhaps long ago made, for the reception of inhabitants. That it is not now preparing may be inferred from the absence of every appearance of change since its surface has been studied by astronomers.

If it is probable, then, that the moon is inhabited, the same degree of probability may be extended to all the other satellites of the system. Their great distance from the earth prevents us from examining their surface; but even without any indication of mountains and valleys, or of any forces that have disturbed or are still disturbing their surface, analogy compels us to conclude, that like all other material spheres, the satellites of the planets must have been created for the double purpose of giving light to their primaries, and a home to animal and intellectual life.

CHAPTER VI.

THE SYSTEM OF COMETS.

THE Solar system consists of two different groups of bodies, namely, the Planetary system and the system of Comets. The Planetary system consists of *eight* primary planets, *thirty* asteroids, and *twenty-two* secondary planets or moons, circulating round their primaries. All the eight primary planets move very nearly in one plane, rising only a few degrees (less than 3° on the average) above the plane of the ecliptic, or that in which the Earth moves round the Sun. The orbits of the thirty asteroids have all degrees of inclination from two-thirds of a degree, that of *Massilia*, to 34° 37′, that of *Pallas*, the average being about 7°. The comets, on the contrary, move at all possible angles to the ecliptic, and in all possible directions, so that if their orbits could be supposed to be fixed and luminous lines, they would form a luminous sphere, on whose equator the planetary system

would be seen as a narrow luminous band, if their orbits were also fixed and luminous.

These two groups of bodies are essentially different in their nature, as well as in the form and position of their orbits. We have already stated that comets resemble a piece of cloud or vapour; but many of them have what is called a nucleus, or what resembles a solid centre, while others have a disc as round and well defined as Jupiter. This nucleus, however, never exhibits phases like the Moon, and therefore cannot be considered as a solid body, though in some comets solidity is indicated by a minute star-like point in the centre.

Comets are as variable in their motions as in their forms. Some move very slowly, and others with such a velocity as to describe an arch of 40° in a day.

There are, doubtless, many hundred comets belonging to the Solar system. The orbits of no fewer than *two hundred* have been collected by Mr. Cooper of Markree Castle, and hundreds more have passed over our system unseen.

Although astronomers have not been able to discover the use of this remarkable and numerous class of celestial bodies, yet it cannot be doubted that they perform some important function in the Solar

system, necessary and useful to all the bodies of the planetary group. Sir Isaac Newton, who has speculated more on the nature of comets than other philosophers, regards their tails as a very fine vapour, which is emitted by the head or nucleus of the comet when heated by the Sun, and he is of opinion that this vapour, so frequently rarefied and diluted, may at last be dissipated and scattered through the whole heavens, and by little and little be attracted towards the planets by its gravity, and mixed with their atmosphere. "For as the seas," as Sir Isaac observes, "are necessary to the constitution of our Earth, in order that the Sun by his heat may exhale from them a sufficient quantity of vapour, which, being collected in clouds, may descend in rains, and water and nourish all the earth for the production of vegetables; or, being condensed by the cold summits of mountains, may run down in springs and rivers; so comets seem to be required *for the conservation of the seas and fluids of planets*, in order that, from their condensed exhalations and vapours, the water consumed in vegetables and putrefaction, and converted into dry earth, may be continually replaced and supplied.[1] For all

[1] It is obvious, from this passage, that Sir Isaac Newton believed in a plurality of worlds. See Chap. IV.

vegetables grow wholly from fluids, and then are, to a great extent, turned into dry earth by putrefaction, a slime perpetually settling from putrefying fluids. Hence it is that the bulk of the solid earth is continually increasing, and that its fluids, if not supplied from any other source, must constantly decrease, and at last entirely fail. I suspect, also, that the comets supply our air with that which is the smallest, and most subtle, and useful part of it, and which is required to sustain the life of everything."[1]

According to these views of our great philosopher, the use of comets is to fill the whole planetary spaces with moisture, and thus to supply each planet, whether primary or secondary, with the moisture which is lost by vegetation, putrefaction, or any other cause. If the planets are not inhabited by man or by beast, this supply of moisture would not be wanted; and it would be a strange supposition that such an array of hundreds of comets should be created to supply our own little planet with the water which it may require.

But even if Sir Isaac Newton's opinion of the use of comets is incorrect, it cannot be doubted that they exercise some function beneficial to the whole planetary system, a function for which we

[1] Principia, Lib. III. Prob. XLI.

can see but little use if the earth only is inhabited. The Solar system, consisting of planets and comets, and satellites, is obviously one magnificent and symmetrical creation,

> "All are but parts of one stupendous whole,"

each part having different and glorious purposes to perform. The function of one comet, could we ascertain it, must be the function of all; the function of one satellite must be the function of all; and the function of one planet must be the function of all the rest. The function of the comets has not yet been revealed to us. The function of our Moon, to give light to the Earth, must be the function of the other twenty-two moons of the system; and the function of the Earth, to support inhabitants, must be the function of all the other planets.

> "From nature's chain, whatever link you strike,
> Tenth or ten thousandth, breaks the chain alike."

CHAPTER VII.

ON THE NEBULAR HYPOTHESIS.

THE reference which has already been made to the *Nebular Hypothesis*, and the adoption of it by the author of the Essay "Of a Plurality of Worlds," render it necessary that we should give some account of it to our readers. Copernicus, Galileo, Tycho, Kepler, and Newton, having no other guide than Scripture, believed that God made the worlds, and upheld all things by the word of His power. After creating by His mighty fiat the gigantic Sun as the centre of the Solar system, He created the planets and their satellites, launching them from their proper positions in space, and with their proper velocities on their daily and annual movements. Philosophers of another school were not satisfied with these views, and, we believe, on the authority of Laplace, that Buffon was the first person, since the discovery of the true system of the world, who attempted to explain the origin of

the planets and their satellites. He supposes that a comet falling upon the sun dashed from it a torrent of matter, which was formed in the distance into different globes of greater or less magnitude, and more or less distant from the great luminary. These globes are the planets and the satellites which, after cooling, become opaque and solid. In this extravagant speculation, the sun and the comets were made by the fiat of the Almighty, and the comets directed by the same power towards the sun. Why, then, was a secondary cause required to make the little planets, when it was dispensed with in the case of the sun and comets? When these two bodies, five hundred times greater than all the planets put together, were made by the direct agency of God, why was not this same agency employed in completing the system?

Dissatisfied with this very puerile hypothesis, Laplace invents another more ingenious, but equally at variance with reason and with Scripture. In order to explain the motion of all the bodies in our system in one direction, he supposes a central sun to be originally created, and made to revolve, with a large atmosphere, which, by excessive heat, expands beyond the orbits of all the planets. Neptune, the most remote, was formed by the outer zone of this

atmosphere being condensed, by cooling and shrinking, into a planet. By the same process Uranus was formed, and last of all, Mercury, the sun's atmosphere having now shrunk within the orbit of that planet. In like manner all the planets, without satellites, threw off rings from themselves, which contracted into satellites.[1] To this hypothesis, it is a sufficient answer to state, that when Laplace proposed it, it was believed that all the planets and satellites moved in the same *direction* from west to east, but since that time all the satellites of Uranus have been found to move in the *opposite direction*, and Mr. Hind has very recently found that the satellite of Neptune also moves in the opposite direction, thus proving that the hypothesis is utterly incapable of explaining the celestial motions.

In this hypothesis the direct creative power of the Almighty was employed in making the sun and his atmosphere, and giving them a motion of rotation. The same power surely, without the agency of secondary causes, might have equally created the planets and satellites, and launched them in their orbits.

[1] From this hypothesis it necessarily follows that all the satellites, as well as the planets, *must have atmospheres.*

In more recent times this speculation has been pushed to a much greater extent. The universe is supposed to be filled with *fire-mist*, or *star-dust*, as it has been called, something like a mixture of smoke and steam. From some unknown cause, two particles attract one another, and are then surrounded by others, which become an infant sun, wriggling itself into motion,—increasing in size, and carrying round with it the whole mass of fire-mist within the orbit of Neptune, and then forming planets and satellites, as in the last hypothesis. Here, as before, the direct creative power of the Almighty is required to generate the fire-mist, but when this is done, His arm is paralyzed, and the Solar system is manufactured by secondary causes.

The Nebular hypothesis has been adopted by the author of the Essay "Of a Plurality of Worlds," the only English philosopher who can be named as giving it the smallest countenance. His object in adopting it is to "find additional proofs in favour of his view of the system," and he employs it to explain how the inferior planets, Venus and Mercury, cannot have inhabitants, "because they have not yet fully emerged from the atmosphere in which they had their origin,—the *mother light*, and *mother fire*, in which they began to crystallize, as

crystals do in their mother water." In like manner he maintains that the four exterior planets—Jupiter, Saturn, Uranus, and Neptune—cannot have inhabitants, because they are "immense clouds," mere "water and vapour packed into rotating masses," having been "driven to the outer parts of the system, or retained there by the central heat of the sun." As for the eighteen or nineteen satellites of these unfortunate water planets, and the thirty asteroids, he pronounces them to be "mere shreds and specks of planetary matter," or "watery globes, with perhaps a lump, or a few similar lumps of planetary matter at their centre."

Such is the addition to the Nebular hypothesis, for which the author claims the high praise of "reducing into consistency and connexion, *in a manner which seems wonderful*, the very extraordinary number of points in the Solar system hitherto unexplained." These points, of which he thus boasts of having discovered the cause, are *twelve* in number; but we deny that he has given the slightest explanation of any one of them, and we assert that there is not a philosopher in the civilized world that thinks otherwise than we do. The hypothesis has not even the merit of ingenuity. It is at once presumptuous and fanciful, subversive of

every principle of the inductive philosophy, degrading to science, incompatible with religious truth, and dishonouring to the great Author of the material universe.[1]

[1] Sir Isaac Newton's opinion of the Nebular hypothesis will be found in Chap. XV. and XVI.

CHAPTER VIII.

THE MOTION OF THE SOLAR SYSTEM ROUND A DISTANT CENTRE.

HAD our Sun, with all the planets and comets which he controls, been absolutely fixed in space, our system could have had no connexion with the other systems of the universe. The immense void that separates it from the stars, would have been regarded as the barrier which confined it. Astronomers, however, have not only placed it beyond a doubt that the Solar system is advancing in absolute space, but have determined the direction in which it moves, and, within certain limits, the velocity of its motion. This great cosmical truth, the grandest in astronomy, proves that our Solar system is not the central system of the universe, and will furnish us with a new argument for a plurality of worlds.

The first astronomer who suggested the idea of

such a motion, was the celebrated Dr. Halley,[1] who was led to it by comparing the places of Sirius, Arcturus, and Aldebaran, as determined by the observations of Hipparchus and Flamsteed. The French astronomers, Cassini and Le Monnier, noticed the same fact; but it is to Tobias Mayer[2] of Göttingen that we are indebted for a more complete examination of the subject. By comparing the places of eighty fixed stars, as determined by Roemer in 1706, with their places as observed by Lacaille in 1750, and himself in 1756, he found that the greater number of them had *a proper motion*, that is, a motion that could not be explained by any cause connected with the motion of the earth in its orbit or upon its axis. In order to explain this motion, he suggested that it might arise from a progressive motion of the sun to one quarter of the heavens, in consequence of which the stars to which he was approaching would appear to recede from each other, while those in the opposite region from which he was moving would appear to approach one another; and he illustrated this idea by supposing a person walking in a field surrounded by trees, in which case the trees to which he approached would appear

[1] *Phil. Trans.*, 1718. No. 355, i. v. vi.
[2] *Opera Inedita*, 1775. *De Motu fixarum proprio*, pp. 77-81.

to separate, or their distance to increase, while those which he left behind would appear to approach to one another, or their distance to diminish, the trees on his right and left hand preserving the same apparent distance from each other. This was the true cause of the proper motion of the stars, but owing to the imperfection of astronomical instruments in the time of Roemer, and even in Mayer's time, the observed proper motion did not correspond with his explanation of it; and he quitted the subject with the remark, that many centuries must elapse before the true cause of this motion can be explained.

Astronomy, however, was advancing more rapidly than its most ardent votaries imagined, and, before a single century elapsed, the motion of the Solar system in space, as the cause of the proper motion of the stars, became a great truth, commanding the assent and the admiration of every cultivator of astronomy.

Although Dr. Wilson[1] of Glasgow had pointed out, on theoretical principles, the probability of a progressive motion of the Sun, and Lambert[2] and La Lande[3] had deduced it from the idea, that the

[1] *Thoughts on General Gravitation*, 1777.

[2] *Système du Monde*, pp. 152-158; and *Lettres Cosmologiques*, 1761, p. 126.

[3] *Mém. Acad. Par.* 1776, p. 513.

same mechanical impulse which gave the Sun its rotatory motion upon its axis, would displace its centre and give it a motion of translation, yet it was not till Sir William Herschel,[1] in 1783, analyzed the accurate observations of Dr. Maskelyne on thirty-five fixed stars, that a decided step was made in the investigation. He found that, in 1790, the Solar system was advancing to the star λ in the constellation Hercules, or to a point in the heavens whose right ascension is 260° 34′, and north declination 26° 17′. By similar calculations, M. Prévost[2] found the right ascension of the same point to be 230°, with north declination 25°; and M. Klugel[3] made it 260°, with north declination 27°,—a result almost the same as that of Sir William Herschel.

It would be inconsistent with the nature of an Essay like this to enter into more minute details upon this subject. We shall, therefore, give a tabular view of the results which have been obtained from places of the fixed stars, taken with the more accurate instruments of the present day, at the principal Observatories in Europe, and by the accomplished astronomers that direct them :—

[1] *Phil. Trans.*, 783, p. 247: 1805, pp. 233-256.
[2] *Mem. Acad. Berlin*, 1781. [3] *Berlin Ephemeris*, 1782.

Right Ascension and Declination of the Point to which the Solar System is advancing.

Observers.		Right Ascension.	Probable Error.	North Declination.	Probable Error.	No. of Stars. used.
Argelander	I.	256° 25′·1	± 12° 21′·8	38° 37′·2	± 9° 21′·4	21
Argelander	II.	255° 9′·7	± 8° 34′·0	38° 34′·3	± 5° 55′·6	50
Argelander	III.	261° 10′·7	± 3° 48′·9	30° 58′·1	± 2° 31′·4	319
Lundahl	IV.	252° 24′·4	± 5° 25′·3	14° 26′·1	± 4° 29′·3	147
Otto Struve	V.	261° 23′·1	± 4° 49′·9	37° 35′·7	± 4° 11′·8	392
Mean result	VI.	259° 9′·4	± 2° 57′·5	34° 36′·5	± 3° 24′·5	

The signs + and − in this table indicate that the probable error may extend on each side of the tabular number, by the quantities before which they are placed.

As the stars from which the preceding deductions have been made were those which are visible in the Observatories of Europe, it became interesting to determine the point to which the Solar system was moving, from the proper motion of the stars that are visible in the Southern hemisphere. This investigation has been lately made by our distinguished countryman, the late Mr. Thomas Galloway,[1] by means of eighty-one stars that were observed by Lacaille in 1751 and 1752, compared with those observed by Mr. Johnson at St. Helena in 1829-1833, and by our countryman, the late Mr.

[1] *Phil. Trans.*, 1847.

Henderson, at the Cape, in 1830, 1831. The result of this inquiry is, that the point of space to which our Sun is approaching is situated, as in the following table :—

Observer.		R. Ascension.	N. Declination.	Prob. Error.
Galloway,	VII.	260° 0′·6 ± 4° 31″·4	34° 23′·4 ± 5° 17′·2	
General Mean,	VIII.	259° 35′·0 ± 8° 44″·4	34° 30′·0 ± 4° 20′·8	

Hence it appears, that the result obtained from the southern stars agrees with that from the northern ones, within 35′ of right ascension, and 7′ of declination, a coincidence so extraordinary as to amount to a demonstration of the great physical truth which it indicates.

But astronomers have not been satisfied with merely determining the direction to which the Sun, with all his planets, is advancing in space: They have calculated, within certain limits of error, the velocity with which he moves! Assuming the parallax of stars of the first magnitude to be 0″·209, as determined by his father, M. Otto Struve finds that the angular value of the annual motion of the Solar system, if seen at right angles from the distance of such a star, is 0″·3392, with a probable error of 0″·03623; and taking the radius of the Earth's orbit as unity, we have $\frac{0''\cdot3392}{0''\cdot209}$ or 1·623, with a

probable error of 0·229, as the annual motion of the Sun in space, reckoned in radii of the Earth's orbit. That is, taking 95 millions of miles as the mean radius of the Earth's orbit, we have 95 × 1·623 = 154·185 millions of miles, and consequently—

		English Miles.
The velocity of the	Solar system is	154,185,000 in a year.
Do.	do.	422,424 in a day.
Do.	do.	17,601 in an hour.
Do.	do.	293 in a minute.
Do.	do.	4·9 in a second.

"Here, then," says M. Struve, senior, "we have the splendid result of the united studies of MM. Argelander, O. Struve, and Peters, grounded on observations made at the three Observatories of Dorpat, Abo, and Pulkova, and which is expressed in the following thesis :—'The motion of the Solar system in space is directed to a point of the celestial vault, situated, on the right line which joins the two stars π and μ *Herculis*, at a quarter of the apparent distance between these stars from π *Herculis*. The velocity of this motion is such, that the Sun, with all the bodies which depend upon him, advances annually in the above direction 1·623 times the radius of the Earth's orbit, or 133,550,000 geographical miles. The possible error of this last number amounts to

17,330,000° geographical miles, or a seventh of the whole value. We may thus wager 400,000 to 1 that the Sun has a proper progressive motion, and 1 to 1 that it is comprised between the limits of 38 and 29 millions of geographical miles.'" [1]

As there is no such thing in the heavens as a rectilineal motion, it is evident that the Sun, with all his planets and comets, is in rapid motion round an invisible body.[2] To that now dark and mysterious centre, from which no ray however feeble shines, we may, in another age, point our telescopes, detecting, perchance, the great luminary which controls our system, and bends its path into that vast orbit which man, in the whole cycle of his race, may never be allowed to round. If the buried relics of primeval life have taught us how brief has been our tenure of this terrestrial paradise, compared with its occupancy by the brutes that perish, the grand sidereal truth which we have been expounding impresses upon us the no less humbling lesson, that from the birth of man to the extinction of his race, the system to which he belongs will

[1] *Etudes d'Astronomie Stellaire*, p. 108.

[2] Professor Mädler, without any very weighty reasons, makes the star *Alcyone* the brightest of the Pleiades, the centre of the Sun's orbit.

have described but an infinitesimal arc in that grand cosmical orbit in which it is destined to revolve. If reason ever falters beneath the weight of its conceptions, it is under this overwhelming idea of time and of space. One round, doubtless, of this immeasurable path will the Sun be destined to describe. How long a journey has it made in the past! How brief in the present! How endless in the future!

We have thus endeavoured to give our readers an accurate idea of the nature and grandeur of this great cosmical movement, not merely because it supplies us with a new argument for a plurality of worlds, but because the author of the Essay already quoted, who denies this doctrine, has completely misrepresented the great truth of the motion of the Solar system. Foreseeing its efficacy as an argument for more worlds than one, he has shunned the description of it even as a theory, and represented it to his readers as among "the conjectures of astronomers," and as founded upon "minute inquiries and bold conjectures," which he need not notice, as they "have no bearing on his subject."[1]

That the sidereal phenomena thus stigmatized are not conjectures, but truths, *admitted by every astronomer*, our readers have seen. That they have a

[1] *Of a Plurality of Worlds*, pp. 157, 158.

bearing on the doctrine which we are maintaining, we shall endeavour to shew. The argument for a plurality of worlds may have two forms. It may embrace a new point of analogy between the inhabited Earth and any of the planets, primary or secondary; and since our Solar system is a system containing inhabitants, even if the Earth is the only planet that contains them, any point of analogy between that system and any other system of stars in which there is a distinct movement of one star round another, becomes an argument for the existence of inhabitants, or of an inhabited planet in the other. It may have also a second form, namely, that which is called a *reductio ad absurdum*, that is, an argument in which it is shewn that the opposite opinion is an absurdity. The strictest truths in geometry have been considered as demonstrated by this species of argument, and it is still more applicable in the present case, where mathematical certainty cannot be attained, because there may be different degrees of absurdity, and we may have an *argumentum ad absurdiorem*, and an *argumentum ad absurdissimum*.

To illustrate this, let us suppose that, at a certain period in the history of astronomy, the Earth was believed to be the only planet that moved round

the Sun. The astronomer of that day must have thought it strange that a sun 882,000 miles in diameter should be employed to light and to heat a planet only 7,926 miles in diameter, seeing that a smaller sun nearer the Earth would have been sufficient for the purpose. When Venus was discovered and found to be a planet of the same size as the Earth, with mountains and valleys, days and nights, and years analogous to our own, astronomers could not fail to think it probable that she was inhabited like the Earth; and the *absurdity* of believing that she had no inhabitants, when no other rational purpose could be assigned for her creation, became an argument of a certain amount that she was like the Earth, the seat of animal and vegetable life. When Jupiter was discovered, and was found to be so gigantic a planet that it required *four* moons to give him light, the argument from analogy that *he* was inhabited became stronger, from the fact of his having moons, and the argument for a plurality of worlds became stronger also, because the analogy was extended to *two* planets. In like manner, every discovery of a new planet, either with new points of analogy, or with those previously existing in other planets, became an additional argument from analogy. When the system, therefore,

was completed by the discovery of Saturn, Uranus, Neptune, and their numerous satellites, and when astronomers had discovered the existence of atmospheres, and clouds, and arctic snows, and trade winds in Saturn, Jupiter, Mars, and Venus, the argument from analogy attained a degree of force which it had not in the time of Fontenelle; and when combined with the absurdity of the opposite opinion that planets could have moons and no inhabitants, atmospheres with no creatures to breathe in them, and currents of air without life to be fanned, it acquired a power of conviction which few minds, if any, could resist.

Considering the Solar system as *stationary in space*, and unconnected with any other system, the argument for the existence of inhabitants on its planets, has a certain fixed value compounded of the argument from analogy, and the degree of absurdity which attaches to the idea of the planets being lumps of moving matter shone upon, and shining in vain. But when we have proved that this Solar system is revolving round some distant centre, in an orbit of such inconceivable dimensions that thousands of years must be required to perform one single round:—When we consider that this distant centre must, from analogy, be a sun,

with attendant planets, like our own, revolving in like manner round our sun, or round their common centre of gravity, the mind rejects, almost with indignation, the ignoble sentiment that man, in his little chariot of Earth, is the only living being that performs this immeasurable journey, and that Jupiter, and Saturn, and Uranus, and Neptune, with their bright array of regal train-bearers, and Mars, Venus, and Mercury are but colossal blocks of lifeless mud and clay encumbering the Earth as a drag, and mocking the creative majesty of heaven.

It is hardly necessary to illustrate these views by more familiar similitudes. The architect of a solar system stationary in space, and with but one of its smallest planets inhabited, may in some degree be likened to a sovereign, who, in sending a military colony to cultivate and defend an island in the Pacific, engaged *twenty-five* soldiers, *one* of whom was a light infantry man, who did all the honours and duties of the island, while the other *twenty-four* were tall and powerful grenadiers, who enjoyed themselves day and night upon merry-go-rounds, heated by genial fires, and lighted by brilliant chandeliers of gas, but performing no useful work, and doing no honour to their king. The Creator

of the same solar system launched into an orbit of immeasurable circuit, and wheeling through ether with the velocity of nearly five miles in a second, may have some resemblance to a mighty autocrat, who should establish a railway round the coasts of Europe and Asia, and place upon it an enormous train of first-class carriages, impelled year after year by tremendous steam power, while there was but a philosopher and a culprit in an humble van, attended by hundreds of unoccupied carriages and empty trucks!

Since every fixed star, considered as the centre of a system, must have planets upon which to shine, we are furnished with a new argument from analogy, from the fact of our Solar system revolving round a sun with a similar system of planets, for as there is at least one inhabited planet in the one system, there must for the same reason be one inhabited planet in the other, and consequently, there must be more inhabited worlds than one—as many, indeed, as there are systems in the universe. This argument will be better understood when we have treated, in a future chapter, of binary systems of stars, to which the Newtonian law of gravity has been found applicable.

CHAPTER IX.

RELIGIOUS DIFFICULTIES.

IT is as injurious to the interests of religion, as it is degrading to those of science, when the votaries of either place them in a state of mutual antagonism. A mere inference or a hypothesis in science, however probable, must ever give way to a truth revealed; but a scientific truth must be maintained, however contradictory it may appear to the most cherished doctrines of religion. In freely discussing the subject of a plurality of worlds, there can be no collision between Reason and Revelation. Christians, timid and ill-informed, have, at different periods, refused to accept of certain results of science, which, instead of being adverse to their faith, have been its best auxiliaries; and infidel writers, taking advantage of this weakness, have vainly arrayed the discoveries and inferences of astronomy against the fundamental doctrines of Scripture. This unseemly controversy, which once

raged respecting the motion of the Earth and the stability of the Sun, and more recently in reference to the doctrines and theories of geology, terminated, as it always must do, in favour of science. Truths physical have an origin as divine as truths religious. In the time of Galileo they triumphed over the casuistry and secular power of the Church; and in our own day the incontrovertible truths of primæval life have won as noble a victory over the errors of a speculative theology, and a false interpretation of the word of God. Science ever has been, and ever must be the handmaid of religion. The grandeur of her truths may transcend our failing reason, but those who cherish and lean upon truths equally grand, but certainly more incomprehensible, ought to see in the marvels of the material world the best defence and illustration of the mysteries of their faith.

In referring to the planets of our own system, and to those which surround the fixed stars as suns, Dr. Bentley justly remarks, "that if any person will indulge himself in this speculation, he need not quarrel with revealed religion upon such an account. The Holy Scriptures do not forbid him to suppose as great a multitude of systems, and as much inhabited as he pleases. 'Tis true there is no mention

in Moses's narrative of the creation of any people in other planets. But it plainly appears that the sacred historian doth only treat of the origin of terrestrial animals: he hath given us no account of God's creating the angels; and yet the same author in the ensuing parts of the Pentateuch, makes not unfrequent mention of the *angels of God.* Neither need we be solicitous about the condition of those planetary people, nor raise *frivolous disputes how far they may participate in* Adam's *fall or in the benefits of* Christ's *incarnation.* As if because they are supposed to be *Rational* they must needs be concluded to be *Men.*" He then goes on to shew that there may be "minds of superior or meaner capacities than human united to a human body," and "minds of human capacities united to a different body" . . . . . "so that we ought not upon any account to conclude that if there be rational inhabitants in the Moon or Mars, or any unknown planets of other systems, they must therefore have human natures, or be involved in the circumstances of our world."[1]

The doctrine of a plurality of worlds,—of the occupation of the planets and stars by animal and intellectual life, has been stated as "a popular argu-

[1] *On the Confutation of Atheism,* &c., 1693, pp. 6-8.

ment against Christianity not much dwelt upon in books, but, it *is believed*, a good deal insinuated in conversation, and having no small influence on the amateurs of a superficial philosophy."[1] Although we have felt that such a difficulty might be made an objection to Christianity, we have never heard it made in conversation, and have met with it only in one infidel publication; but as it has been so prominently brought into view by Dr. Chalmers, and also by the author of the Essay *Of a Plurality of Worlds*, it is necessary to ascertain its value, whether it be urged by the infidel against the truths of Scripture, or by the Christian against the inferences of science.

"Is it likely," as Dr. Chalmers puts it, "says the infidel, that God would send His eternal Son to die for the puny occupiers of so insignificant a province in the mighty field of his creation? Are we the befitting objects of so great and so signal an interposition? Does not the largeness of that field which Astronomy lays open to the view of modern science, throw a suspicion over the truth of gospel history? and how shall we reconcile the greatness of that wonderful movement which was made in

[1] Chalmers's *Discourses*, &c. Discourse I.

heaven for the redemption of fallen man, with the comparative meanness and obscurity of our species?"

In meeting this astronomical objection, Dr. Chalmers states that it consists of an *assertion*, which he denies, that Christianity was established for the exclusive benefit of our minute and solitary world, and of an *inference* or *argument*, that God would not lavish "such a quantity of attention on so insignificant a field." In denying the *assertion*, and maintaining that the inhabitants of other worlds may not have required a Saviour, Dr. Chalmers has obviously cut the knot of the difficulty rather than untied it. The assertion of the infidel, and the assertion of the divine, mutually destroy each other. The *assertion* of the infidel, not his *inference*, has been maintained by some Christians themselves, and is a difficulty which ought not to have perplexed them. The assertion of the *divine*, on the contrary, is one which very few Christians will admit, and one which is opposed to the very system of analogy, which guides us in proving a plurality of worlds. If we argue that Jupiter, a planet with moons, must be inhabited because the Earth which has a moon is inhabited, is not the infidel or the Christian entitled to say, that since the inhabitants of the Earth have sinned and required a Saviour, the in-

habitants of Jupiter may also have sinned, and required a Saviour? To maintain the contrary opinion is not only against analogy, but it is a hazardous position for a divine to take when he maintains it to be probable that there are intellectual creatures occupying a world of matter, and subject to material laws, and yet exempt from sin, and consequently from suffering and death. A proposition so extraordinary we cannot venture to affirm. If it be true, the difficulty of the sceptic and the Christian is at once removed, because there can be no need of a Saviour; and we are driven to the extravagant conclusion, that the inhabitants of all the planets but our own are sinless and immortal beings that never broke the Divine law, and are enjoying that perfect felicity which is reserved only for a few of the less favoured occupants of the Earth. Thus chained to a planet the lowest and most unfortunate in the universe, the philosopher, with all his analogies broken down, may justly renounce his faith in a plurality of worlds, and rejoice in the more limited but safer creed of the anti-pluralist author who makes the Earth the only world in the universe, and the special object of God's paternal care.

We must not, however, permit our readers to

come to such a painful conclusion. Men of lofty minds and of undoubted piety have regarded the existence of moral evil as a necessary part of the general scheme of the universe, and consequently as affecting all its rational inhabitants—the race of Adam on our own globe, and the races, perchance, more glorious than ours in the planets around us, and in the remotest system in space. When on the eve of learning the truth of his opinions, the illustrious Huygens did not hesitate to affirm, that it would be absurd to suppose that all things were made otherwise than God willed, and knew would happen; and that if we had lived in continual peace, and with an abundant supply of all the good things of this life, there would have been neither art nor science, and the human race would soon have lived like the brutes that perish. And with these views he comes to the conclusion, that the inhabitants of the other planets must be endowed with the same vices and virtues as man, because without such vices and virtues they would be far more degraded than the occupants of the Earth.

March 19th 1879.

One of the most profound thinkers and elegant writers of the present day[1] has viewed this subject from a loftier eminence. "From the revealed re-

[1] Mr. Hugh Miller, *Footprints of the Creator*, pp. 301-303.

cord," he says, "we learn that the dynasty of man in the mixed state and character, is not the final one, but that there is to be yet another creation, or more properly re-creation, known theologically as the resurrection, which shall be connected in its physical components by bonds of mysterious paternity, with the dynasty which now reigns, and be bound to it mentally by the chain of identity, conscious and actual; but which in all that constitutes superiority, shall be as vastly its superior as the dynasty of responsible man is superior to even the lowest of the preliminary dynasties. We are further taught, that at the commencement of this last of the dynasties, there will be a re-creation, of not only elevated, but also of degraded beings—a re-creation of the *lost*. We are taught yet farther, that though the present dynasty be that of a lapsed race, which at their first introduction were placed on higher ground than that on which they now stand, and sank by their own act, it was yet part of the original design, from the beginning of all things, that they should occupy the existing platform; and that redemption is thus no after-thought rendered necessary by the fall, but, on the contrary, part of a general scheme, for which provision has been made from the beginning; so that the divine man, through whom the work of resto-

ration has been effected, was in reality, in reference to the purposes of the Eternal, what He is designated in the remarkable text, '*the Lamb slain from the foundations of the world.*' Slain from the foundations of the world! Could the assertors of the stony science ask for language more express? By piecing the two records together—that revealed in Scripture, and that revealed in the rocks—records which, however widely geologists may mistake the one, or commentators misunderstand the other, have emanated from the same great author, we learn that in slow and solemn majesty has period succeeded period, each in succession ushering in a higher and yet higher scene of existence—that fish, reptiles, mammiferous quadrupeds, have reigned in turn,—that responsible man, 'made in the image of God,' and with dominion over all creatures, ultimately entered into a world ripened for his reception; but farther, that this passing scene, in which he forms the prominent figure, is not the final one in the long series, but merely the last of the *preliminary* scenes; and that that period to which the bygone ages, incalculable in amount, with all their well-proportioned gradations of being, form the imposing vestibule, shall have perfection for its occupant, and eternity for its duration. I know not how it may appear to

others; but for my own part, I cannot avoid thinking that there would be a lack of proportion in the series of being, were the period of perfect and glorified humanity abruptly connected, *without the introduction of an intermediate creation of responsible imperfection*, with that of the dying, irresponsible brute. That scene of things in which God became man, and suffered, *seems*, as it no doubt *is*, a necessary link in the chain."

At this startling result, our author finds himself on the confines of a mystery which man has "vainly aspired to comprehend." "I have," says he, "no new reading of the enigma to offer. I know not why it is that moral evil exists in the universe of the All-wise and the all-powerful; nor through what occult law of Deity it is that 'perfection should come through suffering.'" In the darkness of this mystery the best and the brightest spirits are involved; and our inability to fathom its depth we willingly acknowledge. But there are difficulties, which though we cannot solve them for others, we may solve for ourselves. An inferior intellect may disencumber itself of an incubus, which a superior one may be doomed for ever to bear. And as the physician, when he cannot achieve a cure, considers himself fortunate when he finds an anodyne, so the

Spectre of Moral Evil may haunt the philosopher when the peasant has succeeded in exorcising it.

To exhibit the Divine attributes, and to display the Divine glory to an intellectual and immortal race, must have been the purpose for which a material universe was created. In his physical frame Man is necessarily subject to physical laws. The law of gravity "cannot cease as he goes by;"—and finite in his nature, and fallible in his reason, he can but feebly defend himself against the ferocity of animal life, the power of the elements, or the poison that may mingle in his cup. His high reason does not, in many emergencies, compensate for his inferior instinct. He is therefore helplessly exposed to suffering and death. The instincts of self-preservation and of parental affection give a magnitude and interest to whatever affects the safety and happiness of himself and his offspring. He is thus placed in antagonism to his fellow-sufferers, and in the collision of interests and feelings, laws human and Divine are broken. Nor is this result less conformable to what we have regarded as the object and end of creation. In order to glorify God by a knowledge of His attributes, these attributes must be fully displayed. The power, and wisdom, and goodness of the Creator, are exhibited to us every day and every

hour ;—they are proclaimed in the heavens ;—they are stamped on the earth ;—life, and the enjoyments of life, display them even to the dumb, the deaf, and the blind. But in what region are we to descry the attributes of mercy, of justice, and of truth? In the abodes of happiness and peace, the idea of Mercy can neither have an object nor a name. Justice can be understood only among the unjust,—and truth only among the untruthful. The moral attributes of the most High can be comprehended and emblazoned only among the cruel, the dishonest, and the false. His power, wisdom, and goodness, can be exhibited only in a material world, governed by the laws of matter ; and man in his material nature must be subject to their operation and control. Though thus controlled and thus suffering, we feel that all is good and wise, and under this feeble gleam of reason there is light enough to show us—if we are disposed to have it shown—that the Spectre of Moral Evil has been conjured up by ourselves :

> All Nature is but art, unknown to thee;
> All chance direction, which thou canst not see;
> All discord, harmony not understood;
> All partial evil, universal good.—POPE.

If we reject, then, the idea that the inhabitants of

the planets do not require a Saviour, and maintain the more rational opinion, that they stand in the same moral relation to their Maker as the inhabitants of the Earth, we must seek for another solution of the difficulty which has embarrassed both the infidel and the Christian. How can we believe, says the timid Christian, that there can be inhabitants in the planets, when God had but one Son whom He could send to save them? If we can give a satisfactory answer to this question, it may destroy the objections of the infidel, while it relieves the Christian from his anxieties.

When, at the commencement of our era, the great sacrifice was made at Jerusalem, it was by the crucifixion of a man, or an angel, or a God. If our faith be that of the Arian or the Socinian, the sceptical and the religious difficulty is at once removed:—a man or an angel may be again provided as a ransom for the inhabitants of the planets. But if we believe, with the Christian Church, that the Son of God was required for the expiation of sin, the difficulty presents itself in its most formidable shape.

When our Saviour died, the influence of His death extended backwards, in the past, to millions who never heard His name, and forwards, in the

future, to millions who will never hear it. Though it radiated but from the Holy City, it reached to the remotest lands, and affected every living race in the old and the new world. Distance in time and distance in place did not diminish its healing virtue.

> "Though curious to compute,
> Archangels failed to cast the mighty sum."

"Ungrasped by minds create," it was a force which did not vary with any function of the distance. All-powerful over the thief on the cross, in contact with its divine source, it was in succeeding ages equally powerful over the Red Indian of the west, and the wild Arab of the east. Their heavenly Father, by some process of mercy which we understand not, communicated to them its saving power. Emanating from the middle planet of the system, because, perhaps, it most required it, why may it not have extended to them all—to the planetary races in the past, when "the day of their redemption had drawn nigh;" and to the planetary races in the future, when "their fulness of time shall come?"

> "When stars and suns are dust beneath His throne,
> A *thousand* worlds so bought were bought too dear."

But, to bring our argument more within the reach of an ordinary understanding, let us suppose that

our globe at the beginning of the Christian era had been broken in two, as the comet of Biela is supposed to have been in 1846, and that its two halves, the old world and the new, travelled together like a double star, or diverged into widely separate orbits. Would not both its fragments have shared in the beneficence of the cross,—the old world as liberally as the new,—the penitent on the shores of the Mississippi, as richly as the pilgrim on the banks of the Jordan? If the rays, then, "of the Sun of righteousness, with healing on His wings," could have shot across the void between our European and American worlds thus physically dissevered, may not all the planets, the worlds made by our Saviour himself, formed out of the same material elements, and basking under the same beneficent sun, be equal participators in His heavenly gift?

Should this view of the subject prove unsatisfactory to the anxious inquirer, we may suggest for his consideration another sentiment, even though we ourselves may not admit it into our creed. If one man can expiate the crime of another by a punishment short of death, he may perform the same generous deed for a thousand. Should such a noble martyr consent even to give his life for his friend, by suffering a death from which science

could revive him, he might expiate the crimes of thousands of his race. May not the Divine nature, which can neither suffer nor die, and which in our planet, *once* only, clothed itself in humanity, resume elsewhere a physical form, and expiate the guilt of unnumbered worlds?

In his zeal to overthrow the objection of the infidel, Dr. Chalmers has, we think, subjected it to a species of unnecessary torture. When the infidel thinks it unlikely "that God would send His eternal Son to die for the puny occupants of so insignificant a province of His creation," he does not mean that God cannot and does not take care "of the insignificant province" of the earth, because He has so many other nobler planetary kingdoms to govern. He means only that the mission of God's own eternal Son was too great a gift to the earth, and therefore one not likely to be given. The objection, indeed, which Dr. Chalmers puts into the mouth of the infidel is, in truth, an objection felt by the Christian; and the acute author of the Essay *Of a Plurality of Worlds*, seeing this mistake, actually treats it "not as an objection urged by an opponent of religion, but rather as a difficuly felt by a friend of religion." He considers it as a difficulty bearing on natural religion, and in this aspect he accepts of

it as a difficulty, discusses its importance, and regards Dr. Chalmers's reply to it as "well fitted to remove the scruples to which it is especially addressed." The difficulty is thus put by the anonymous author we have referred to:—

"Among the thoughts which it was stated *naturally* arose in men's minds when the telescope revealed to them an innumerable multitude of worlds besides the one we inhabit was this:—*that the Governor of the Universe, who has so many worlds under His management, cannot be conceived as bestowing upon this earth, and its various tribes of inhabitants, that care which, till then, natural religion had taught men that He does employ to secure to man the possession and use of his faculties of mind and body, and to all animals the requisites of animal existence and animal enjoyment.* And upon this Chalmers remarks, that just about the time when science gave rise to the suggestion of this difficulty, she also gave occasion to a remarkable reply to it. Just about the same time that the invention of the *telescope* shewed that there were innumerable worlds which might have inhabitants *requiring the Creator's care* as much as the tribes of this earth do, the invention of the *microscope* shewed that there were in this world innumerable tribes of animals which had been all along enjoying the

benefit of the Creator's care as much as those kinds with which man had been familiar from the beginning. The *telescope* suggested that there might be dwellers in Jupiter or in Saturn, of great size and unknown structure, who must share with us the preserving care of God. The *microscope* shewed that there had been close to us, inhabiting minute crevices and crannies, peopling the leaves of plants and the bodies of other animals, animalcules of a minuteness hitherto unguessed, and of a structure hitherto unknown, who had been always sharers with us in God's preserving care. The *telescope* brought into view worlds as numerous as the drops of water which make up the ocean; the *microscope* brought into view a world in every drop of water. Infinity in one direction was balanced by infinity in the other. The doubts which man might feel as to what God would do, were balanced by certainties which they discovered as to what He had always been doing. His care and goodness could not be supposed to be exhausted by the hitherto known population of the Earth, for it was proved they had hitherto been confined to that population. *The discovery of new worlds at vast distances from us* was accompanied by the discovery of new worlds close to us, even in the very substances with which we

were best acquainted, and *was thus rendered ineffective to disturb the belief of those who had regarded the world as having God for its Governor.*"

The difficulties, or "scruples," so distinctly stated in the preceding extract, whether we view them as an objection urged by an opponent of religion, as Dr. Chalmers does, or as a difficulty felt by the Christian, have, in our opinion, no existence; and, if they had, we consider the discoveries of the microscope as having no tendency whatever to remove them. It is a singular doctrine to maintain, that "the truths of natural religion" were ever exposed to danger by the discoveries of the telescope, or that astronomical truth ever excited the "doubts or difficulties," stated by our author, either in the minds of Theists or Christians of the most ordinary capacity. We have never read any reputable works containing such doubts, nor listened to any conversations in which they were the subject of discussion. Amid the destructive convulsions of the physical world, even pious minds may have for an instant questioned the superintending providence of God. In the midst of famine, or pestilence, or war, they may have stood horror-struck at the scene. In the triumphs of fraud, oppression, and injustice, over honesty, and liberty, and law, Faith may have

wavered, and Hope despaired; but in no condition, either of the physical or the moral world, does the mind question the POWER of its Maker. The *omnipotence* of the Creator, and the exertion of it in every corner of space,—His care over the falling sparrow, and His guidance of the gigantic planet, are the earliest of our acquired truths, and the very first that observation and experience confirm. When Reason gives wisdom to our conceptions, omnipotence is the grand truth which they inculcate. Whatever the eye sees, or the ear hears, or the fingers touch,—every motion of our body, every function it performs, every structure in its fabric, impresses on the mind, and fixes in the heart the conviction, that the Creator is all-powerful as well as all-wise. Omnipotence, in short, is the only attribute of God which is universally appreciated, which scepticism never unsettles, and which we believe as firmly when under the influence of our corrupt passions, as when we are looking devoutly to heaven. All the other attributes of God are inferences. His omnipresence, His omniscience, His justice, mercy, and truth, are the deductions of reason, and, however true and demonstrable, they exercise little influence over the mind; but the attribute of omnipotence predominates over them

all, and no mind responsive to its power will ever be disturbed by the ideas which it suggests of infinity of time, infinity of space, and infinity of life.

Is it conceivable that a Theist or a Christian of the smallest mental power could suppose that there are *degrees of omnipotence*, and imagine that the Almighty might be prevented, by the *many worlds under His management*, from taking care of the Earth and its inhabitants? If that Being who has made the living world which we see, can make millions of worlds, the same power which takes such care of its inhabitants that not a hair of their head can fall to the ground without His knowledge, can equally embrace in His capacious affections, and clasp in "the everlasting arms," all the families of the universe.

But even if we admit that such imperfect notions of omnipotence have been entertained, we deny that the discoveries of the microscope have the slightest tendency to correct them. Without alleging, as we might well do, that minds cherishing such notions of the Deity are incapable of appreciating the great truths, that there are "new worlds close to us;" that there is "a world in every drop of water;" and that "these worlds are as numerous as the drops in

the ocean," we maintain that minds of the highest cast view the microscopic worlds as creations of an entirely different order from those disclosed by the telescope, and that such minds can never reason from *animalcular* to *intellectual* life. We admit, that the very same care which is required to preserve even an atom of invisible life, is necessary to maintain the gigantic forms of the elephant or the mammoth; but ordinary minds, and those who think that their Maker may have *too much to do*, cannot comprehend, and therefore cannot receive, the doctrine that God takes care of mites and mosquitoes, and the other denizens of the microcosm at their feet,—of animalcules which they swallow in myriads at every act of deglutition,—which they suffocate in millions by every breath they draw,—and which, at every step, they trample relentlessly under their feet.

The religious difficulty has been presented in another form by the author of the Essay *Of a Plurality of Worlds*, but in a form so unintelligible to us, that we acknowledge our inability to comprehend it. Considering Man as an *intellectual*, *moral*, and *religious* creature, and having a progressive history in the development of these different conditions or privileges, as our author calls them,

he sees a great difficulty in supposing that intellectual and responsible creatures analogous to man, can have a place in any of the other planets of our system. Viewing, he says, "the mode of existence of human species upon the earth as being *a progressive existence*, even in the intellectual powers and their results, necessarily fastens down our thoughts and our speculations to the earth, and makes us feel *how visionary and gratuitous it is to assume any similar kind of existence in any region occupied by other beings than men*;" and he elsewhere asserts, "that if we will people other planets with creatures intelligent as man is intelligent, *we must not only give to them the intelligence, but the intellectual history of the human species*." This assertion is supported by another assertion, "that the Earth and its *human* inhabitants are, as far as we yet know, *in an especial manner* the subject of God's care and government;" and from these and other assertions, in reference to man being under the moral government of God, and to the Earth being the theatre of the scheme of redemption, he comes to the incomprehensible conclusion, *that man's nature and place is unique*, and incapable of *repetition in the scheme of the universe!*

In order to test the accuracy of these assertions, and to discover what bearing they have upon the

doctrine of a plurality of worlds, we must ascertain what has been, and what now is, the *progressive history* of man, as an *intellectual*, *moral*, and *religious* creature; and in what age, and in what regions of the globe it has presented, or does now present, that *unity of character and position which is incapable of repetition in the scheme of the universe.*

The history of the human species is the history of a variety of races in every stage of civilisation and barbarism, the great majority of which have neither an *intellectual*, nor a *moral*, nor a *religious progressive* history. Progression has not been the character of the history of man. Without alluding to his primeval fall from his high estate, we have only to cast our eye over the globe, and look at the intellectual, moral, and religious catastrophes which it presents to us,—at ages of light and darkness,—at alternations of progress and decline,—at the highest civilisation sinking into the lowest barbarism. Mark those eastern lands, now involved in darkness, from which the beams of knowledge first radiated on mankind. Study the extinction of morality in many regions of the earth where its great lessons were first taught by our Saviour and His apostles; and above all, ponder over the total suppression of the Christian faith in European communities, where

it has been displaced by a religion whose doctrines were preached by conquest, and whose decalogue was dictated by the sword.

May we not ask, then, which of these ever-changing conditions of humanity is that *unique* condition which cannot be repeated in the scheme of the universe? If it is the intellectual, moral, and religious race which is typified by Newton, and Shakespeare, and Milton, why may it not be the lowest in the scale of existence in some glorious planet, where the understanding, and the affections, and the imagination are to rise into higher forms of science, of poetry, and of philanthropy? Why may not the red Indian, the black negro, and the white slave, be the condition of intelligence in another sphere,—to be elevated to a nobler type of reason, and to a happier and a holier lot? And why may there not be an intermediate race between that of man and the angelic beings of Scripture, where human reason shall pass into the highest form of created mind, and human affections into their noblest development?

It is strange, and hardly credible, that the writer, whose opinion we are considering, should think it necessary that the planets, if inhabited, should be occupied by beings like man. Huygens, Bentley,

Laplace, Isaac Taylor, Sir H. Davy, and Chalmers, have taken a different and a sounder view of the subject. The diversity in the races of man,—the immense and beautiful variety of forms and natures in the world of instinct,—and the countless beauties and differences in the structures and properties of vegetable and mineral bodies, whether of the ancient or the present earth, all concur in satisfying us that there will be the same diversity in the occupants and in the productions of the planetary regions.—Why may not the intelligence of the spheres be ordained for the study of regions and objects, unstudied and unknown on earth? Why may not labour have a better commission than to earn its bread by the sweat of its brow? Why may it not pluck its loaf from the bread-fruit tree, or gather its manna from the ground, or draw its wine from the bleeding vessels of the vine, or inhale its anodyne breath from the paradise gas of its atmosphere?

But whatever races be in the celestial spheres, we feel sure that there must be *one*, among whom there are no man-eaters—no parent-slayers—no widow-burners—no infant-killers—no heroes with red hands—no sovereigns with bloody hearts—no corrupt legislators, and no statesmen who, by

leaving the people untaught, educate them for the scaffold. In the decalogue of that community will stand pre-eminent, in letters of burnished gold, the highest of all social obligations—

THOU SHALT NOT KILL,

—neither for territory, for fame, for lucre, nor for crime,—neither for food, nor for raiment, nor for pleasure. The lovely forms of life, and sensation, and instinct, so delicately fashioned by the Master hand, shall no longer be destroyed and trodden under foot, but be objects of unceasing love and admiration,—the study of the philosopher, the theme of the poet, and the auxiliaries and companions of man.

The difficulties we have been considering, in so far as they are of a religious character, have been very unwisely introduced into the question of a plurality of worlds. They have, indeed, no real connexion with it. Before the advent of our Saviour, such difficulties could not have been started; and had it been previously an article of faith that Jupiter was inhabited, the appearance on Earth of a Redeemer would not have interfered with it. We are not entitled to remonstrate with the sceptic, but we venture to doubt the soundness

of that philosopher's judgment, who thinks that the truths of natural religion, are affected by a belief in planetary races, and the reality of that Christian's faith who considers it to be endangered by the conviction that there are other worlds than his own.[1]

[1] A very able work, by the Rev. Dr. Edward Nares, was published in 1801, entitled "Εἷς Θεὸς, Εἷς Μεσίτης, or an attempt to shew how far the Philosophical notion of a Plurality of Worlds is consistent or not so with the language of the Holy Scriptures." He endeavours to shew that the words Οικουμένη—Οὐρανὸς—Κόσμος,—*Mundus, Orbis*, &c., refer to a universe of worlds, and that the atonement was made for the *creature* generally. The same opinion is maintained by Bishop Porteous, who thinks it evident from Scripture, as well as analogy, that we are not the only creatures in the universe interested in the sacrifice of our Redeemer. (See his Works, vol. iii. p. 70.)

Dr. Andrew Fuller, in his work entitled, *The Gospel its own Witness*, has devoted a whole chapter of forty pages, to shew "The consistency of the Scripture doctrine of Redemption with the modern opinion of the Magnitude of Creation,"—that is, with the doctrine of a plurality of worlds, and systems of worlds. He is of opinion "that the credibility of the Redemption is not weakened by this doctrine, but, on the contrary, is, in many respects, strengthened and aggrandized." We recommend this work to the careful perusal of those who feel any difficulty on the subject, and also a Lecture by the late Rev. S. Noble, entitled, "The Astronomical Doctrine of a Plurality of Worlds in perfect harmony with the True Christian Religion."

CHAPTER X.

SINGLE STARS AND BINARY SYSTEMS.

IF we suppose ourselves placed successively on Mars, Jupiter, Saturn, Uranus, and Neptune, the sun will appear smaller and smaller, and on Neptune it will still have a round and distinctly defined disc. At a greater distance beyond our system the disc of the Sun could be seen only through a telescope, and at that distance all the planets, except Jupiter and Saturn, will have disappeared. At greater distances still these two planets will vanish in succession, and before we have crossed the immense void which lies between our system and the nearest system of the stars, our Sun will be seen as a single star twinkling in the sky. All his planets, primary and secondary, and all his comets, will then have disappeared.

Hence we are led to believe, with Huygens, that the fixed stars, three thousand in number, as seen by the naked eye, and about *one hundred million* as seen

by the telescope, are the suns of other systems, whose planets are invisible from their distance. As no change of place has been observed in *single* fixed stars, excepting that which is common to them all, and which arises from the motion of our system, we are entitled to consider these stars as the centres of systems like our own: To suppose them without planets, and to be merely globes of light and heat, would be contrary to analogy as well as to reason. We know that there is one star (our sun) in the universe surrounded by planets, and one of these planets inhabited; and when we see another single star equal, if not greater in brilliancy, we are entitled to regard it as the centre of a system, and that system with at least one inhabited planet. This conclusion is rendered more probable by estimates which have been made of the comparative brightness and probable magnitude of some of the single fixed stars.[1]

[1] With the view of shewing that analogy does not lead us to believe that stars, considered as suns, are surrounded with planets the author of the Essay *Of a Plurality of Worlds*, has, in a note, quoted in the following manner, a passage from Humboldt, as confirming his opinion.

"Humboldt," says he, "regards the force of analogy as tending in the opposite direction. 'After all,' he asks, (*Cosmos* III. 373,) 'is the assumption of satellites to the fixed stars so absolutely necessary? If we were to begin from the outer planets, Jupiter, &c., analogy might seem to require that all planets have satellites. But yet this is not true, for Mars, Venus, and Mercury have no

These estimates have been obtained from measures of the brightness and distance of a small number of stars. The distance of a star is obtained from what is called its *Parallax*,—namely, its change of place in the heavens when seen from the two most distant points of the earth's orbit, or, what is the same thing, the angle subtended at the star by lines drawn from it to the two most distant points of the earth's orbit, which are separated by a length of 190 millions of miles. The following are almost the only correct measures of parallax which have been obtained by the fine instruments, and the accurate observations of modern astronomers.

satellites, to which we may further add the *twenty-three* planetoids. In this case there is a much greater number of bodies which have not satellites than which have them.' "—P. 161, *note*.

There is certainly some singular confusion of ideas either in Humboldt or his commentator, or in both. Nobody ever maintained that the stars have *satellites*. They are supposed only to have planets, and if any person should maintain that these primary planets have satellites, the observation of Humboldt would be quite applicable, because analogy tells us that it is as likely that they have no satellites as that they have them, or rather, as in the Solar system, that some may have satellites, and others not. The author of the Essay, however, means by satellites not moons, but primary planets, and he has certainly made an extraordinary blunder, when he infers that there may be no planets round the star suns, because there are planets without satellites. If there had not been in the Solar system a single satellite, analogy could never have led us to conclude that there were no primary planets round the stars.

α Centauri,	0″·913	Henderson and Maclear.
61 Cygni,	0″·374	Bessel.
α Lyræ,	0″·207	Peters.
Sirius,	0″·230	Henderson.
Arcturus,	0″·127	Peters.
Pole Star,	0″·106	Peters.
Capella,	0″·046	Peters.

The star α *Centauri*, which is the nearest to our system, has been found to be about two-and-a-half times brighter than our Sun, and the star *Sirius*, the brightest in the heavens, has been found to be four times brighter than α *Centauri*; but the distance of *Sirius* is four times greater than that of α *Centauri*, and therefore the intrinsic brightness of Sirius is sixty-three times greater than that of our Sun. A luminary like this, so resplendent in its brightness, and so gigantic, doubtless, in its magnitude, was surely not planted in space to shed its light and its heat upon nothing. The star *Capella*, too, a star of the first magnitude, is *twenty* times more remote than α *Centauri*, and must, like Sirius, be a sun of enormous size. Can we doubt, then, that every *single* star, shining by its own native light, is the centre of a planetary system like our own, the lamp that lights, the stove that heats, and the power that guides in their orbits inhabited worlds like our own?

A great number of the fixed stars, some of which are of the first magnitude, like *Castor*, appear *double*

when seen through the fine telescopes of modern times, and, from observations made at different dates, one of the stars has been found to revolve round the other, and to form what is called a *Binary System*;—that is, a system in which one sun with its system of planets revolves round another sun with its system of planets, or rather round the centre of gravity of both. The two suns of course are only seen, owing to the great distance of their respective systems from us; but no person can believe that two suns could be placed in the heavens for no other purpose than to revolve round their common centre of gravity.

The orbits of no fewer than *thirteen* double stars, or *binary systems*, first discovered by Sir William Herschel, have been calculated by Sir John Herschel, Savary, Mädler, Admiral Smyth, Hind, Encke, and Jacob, and there can be no doubt that the Newtonian law of gravity extends to these bodies. The periods of these systems extend from 31½ years, which is that of *ζ Herculis*, to 737 years, which is that of *σ Coronæ* B, both of which were calculated by Mädler; but the most interesting binary system is *γ Virginis*, whose revolution, as computed by Sir John Herschel, is 182 years. The two stars which compose it are nearly equal, and, according to

Struve, slightly variable, being sometimes equal in brightness, and sometimes unequal. Dr. Bradley had observed, in 1718, the apparent direction of the line joining the two stars. In 1780, Sir William Herschel observed their distance to be 5″·7, which regularly diminished till 1836, when the two appeared perfectly round, like a single star seen by the finest telescopes. After 1836 the stars separated, and their distance is now more than 2″. The change in their angular motion, that is, in the direction of the line joining them, has been equally remarkable, and was as follows :—

In 1783,	½°	per annum.
1830,	5°	...
1834,	20°	...
1835,	40°	...
1836,	70°	...

The star of the shortest period, namely, *ζ Herculis*, has performed two revolutions since it was first discovered, and the small star has been twice completely eclipsed by the large one. Other three double stars, *η Coronæ*, *ζ Cancri*, and *ξ Ursæ Majoris*, have performed more than one complete revolution in their orbits, and there can be no doubt that these motions are the result of centripetal forces varying inversely as the square of the distance. "We have

the same evidence, indeed," says Sir John Herschel, "of their motions about each other that we have of those of Uranus and Neptune about the Sun; and the correspondence of their calculated and observed places in such very elongated ellipses must be admitted to carry with it proof of the prevalence of the Newtonian law of gravity in their systems, of the very same nature and agency as that of the calculated and observed places of comets round the central body of our own."

In reference to systems like these, the argument in favour of their being surrounded with inhabited planets, is stronger than in the case of single systems. We have in this case a decided visible movement of one of the stars round the other: We have also elliptical orbits described by the same law of force which guides our own Earth and the other planets in the Solar system; and though, upon the same grounds which led us to agree with Sir William Herschel in thinking that our own Sun may be inhabited, we may believe the two suns of binary systems to be inhabited, yet it is more reasonable and consistent with analogy to believe that each of them is accompanied, as Sir John Herschel remarks, "with its train of planets and their satellites, closely shrouded from our view by the splendour of their

respective suns, and crowded into a space bearing hardly a greater proportion to the enormous interval which separates *them* than the distances of the satellites of our planets from their primaries bear to their distances from the Sun himself. A less distinctly characterised subordination would be incompatible with the stability of their systems, and with the planetary nature of their orbits. Unless closely nestled under the protecting wing of their immediate superior, the sweep of their other sun, in its perihelion passage round their own, might carry them off, or whirl them into orbits utterly incompatible with the *conditions necessary for* the existence of their inhabitants." [1]

From the motion of our own system round a distant centre, it is highly probable that our sun is one of a binary system, although its partner has not been discovered. If Mädler's speculation is correct, our sun and the star *Alcyone* form a binary system, and therefore since our sun is attended with planets, and one of these inhabited, we are entitled by analogy to conclude that all other binary systems have planets at least round one of their suns, and that one of these planets is the seat of vegetable and animal life.

[1] *Outlines of Astronomy*, § 846.

The number of double stars, of multiple stars, and groups and clusters is very great; but ages must elapse before astronomers can determine the relation in which the stars that compose each system or group stand to one another. In the meantime we are compelled to draw the conclusion, that wherever there is a sun, a gigantic sphere, shining by its own light, and either fixed or moveable in space, there must be a planetary system, and wherever there is a planetary system, there must be life and intelligence.

The number of fixed stars, even though more numerous than the atoms of sand on the sea shore, forms no argument to the instructed mind against their being occupied by living beings. When the philosopher, with his microscope, discovered that the polieschiefer of Bohemia, and chalk and solid marble, consisted almost wholly of the remains of animal life, the world stood aghast at the intelligence:—They were still more astonished at the statement that many thousands of millions of such infusorial animals could be counted in a cubic inch of their lifeless remains; but their faith was more severely taxed when they learned that whole strata and hills were formed of these fossil skeletons.[1]

[1] Ehrenberg found that one cubic inch of the Bilin polieschiefer slate contains 41,000 millions of these microscopic infusorial

In like manner we are at first startled with the deduction that the planets of our own system are the seats of intellectual life. We marvel still more at the announcement that the systems of the stars are planetary, and inhabited like our own; and our faltering reason utterly fails us when we are called upon to believe that *even the nebulæ* must be surrendered to life and reason. Wherever there is matter there must be Life; Life Physical to enjoy its beauties—Life Moral to worship its Maker, and Life Intellectual to proclaim His wisdom and His power.

animals, called *Galionella distans*, and that a cubic inch of the same material contains above one billion 750,000 millions of distinct individuals of *Galionella ferruginea*.

CHAPTER XI.

CLUSTERS OF STARS AND NEBULÆ.

AMONG the bodies of the sidereal universe, astronomers have from the earliest ages recognised the existence of *clusters of stars* and of *nebulæ*. The *Milky Way* indicates by its name that it is of a *nebular* character; but a nebula, properly so called, is a limited space of light, of various forms and various degrees of brightness in its different parts. Sir William Herschel, who was the first astronomer that observed this class of phenomena systematically, divided the bodies which compose it into *six* classes, namely,

1. *Clusters of stars*, in which each star is distinctly seen.

2. *Resolvable Nebulæ*, or such as *excite a suspicion* that they consist of stars, and which a higher magnifying power *may be expected* to resolve into separate stars.

3. *Nebulæ*, properly so called, in which *there is no appearance whatever of stars*.

4. *Planetary Nebulæ*, or such as resemble planets from their discs being round or slightly oval.

5. *Stellar Nebulæ*, or those in which the light is nearly collected into one point; and

6. *Nebulous* Stars, or luminous points, surrounded with an immense visible atmosphere.

It is very obvious that the language used in the above classification, is intended to support the hypothesis that there is such a thing in the sidereal universe as *real nebulous matter*, or fire-mist, or star-dust, as it has been almost jocularly called, contra-distinguished from a nebulous mass of identically the same appearance which the telescope has resolved into separate stars. The phrases which we have put in italics are certainly incorrect, because *any appearance*, or *any expectation* of a nebula not being resolvable, is proved to have been erroneous the moment it is resolved. The classification of nebulæ, therefore, should have been, 1. Nebulæ that the telescope *had resolved;* and, 2. Nebulæ that the telescope *had not resolved.*

Sir William Herschel believed in the existence of purely nebulous matter, or star-dust, and in what has been called the *theory of sidereal aggregation;* and since his time it has been made the basis of wild and extravagant speculations equally incompatible with

physical and revealed truth. It is, therefore, of some importance that we should succeed in convincing the reader that the existence of nebulæ not yet resolved, is no proof of the existence of star-dust, and that we are entitled to conclude that such nebulæ are clusters of stars,—that each star is the sun of a planetary system, and each planet the residence of life and reason. Each nebula, in short, corresponds with our hill of microscopic infusorial animals,—each system with a cubic inch of its materials, and each planet with a cubic line. If we have seen with our own eyes in the microscope the individual animal—only the *ten thousandth* part of an inch in size, and if we have seen the hill which is an accumulation of them, need we wonder at nebulæ being stars,—at stars being suns,—and at planets being inhabited?

As it is now an astronomical fact that nebulæ, which Sir William Herschel, with his finest telescopes, could not resolve, and which had *no appearance* whatever of being resolvable, have been resolved into distinct stars by the magnificent reflectors of Lord Rosse, we are enabled without any hypothetical statements to place the question of the existence of star-dust or purely nebulous matter, in its proper aspect;—that is, we can assign a

satisfactory reason to the reader for considering every unresolved nebula in the heavens as a cluster of stars which is likely to be resolved by telescopes superior to those of Lord Rosse.

For this purpose, let us suppose *seven clusters of stars* placed at seven different distances in space, all of which were regarded as nebulæ before the invention of the telescope. When Galileo applied his little telescope to nebula No. 1, or the nearest of the seven, he observed it to consist of separate stars so distinct that he could count them, and he concluded from their having no parallax, and being at an enormous distance, that each was a gigantic sun. Galileo tries in vain to resolve No. 2, which is at a greater distance, and therefore though he thought that a better telescope would resolve it and all the other five, they still remained as nebulæ in the heavens. Sir Isaac Newton, however, nearly a century later, applies his little reflecting telescope to No. 2, and succeeds in resolving it, but though he fails in resolving the other five nebulæ, he believes, on better evidence than Galileo, that they are clusters of stars. Hadley with his fine Gregorian reflector easily resolves No. 3; James Short, in like manner, resolves No. 4; Sir William Herschel No. 5; and Lord Rosse No. 6. Now all these

astronomers, after the observation of Galileo, believed that the seven nebulæ were clusters of stars, each of them with increasing evidence; and Lord Rosse, that No. 7 was a cluster on stronger evidence than the rest. Lord Rosse, however, fails in resolving No. 7 with his largest instrument, but he does not scruple to express his conviction, nay, he cannot help being convinced, that with a telescope even a little larger than his own, but certainly with one twice its size, which may be the work of another century,—the *seventh* nebula will also be resolved. The same reasoning which we have used for *seven* nebulæ is applicable to *seventy* or *seven hundred*, or even *seven thousand;* and the conclusion is inevitable, though the evidence of demonstration is wanting, that all nebulæ are clusters of stars.

There is another point of view from which we may regard this subject. Purely nebulous matter, such as that which composes comets' tails, and still more that which, in the form of the *zodiacal* light, is, without reason, called the sun's atmosphere, must consist of the minutest particles, so minute that they do not retard Venus or Mercury while they pass through the so-called atmosphere of the sun, which is alleged to extend beyond their orbits. Now, if No. 6 was considered a nebula before it

was resolved, it must have been regarded as consisting of *minute particles* of star-dust, whereas, the moment it was resolved, it consisted of separate suns, each of which was probably greater than our own. Is it possible that self-luminous star-dust, at such an infinite distance from us in space, and so rare as to be like a non-resisting medium, could send to our system a light as intense as that which is emitted by the same nebula considered as a cluster of suns! If the resolved nebula No. 6, and the unresolved nebula No. 7, have the same appearance and the same intensity of light, is it not certain that the latter must have the same constitution as the former, that is, must consist of stars?

There is another aspect of this question, which, as it has not yet been the subject of discussion, may deserve the attention of astronomers. It is not only quite possible, but we think it is almost certain, that in the distant sidereal spaces there may be nebulæ, which, though really clusters of stars, never can be resolved. Our hypothetical nebula, for example, No. 7, may not only resist the telescopes of ages to come, but may be incapable of resolution by *telescopes of infinite power and infinite perfection.* Unless when a star is in the zenith, the rays by which we see it are bent and dispersed by

the refraction of the atmosphere, and as our atmosphere is not a homogeneous medium, a star may be so infinitely minute from its distance, that though its light makes its way through ethereal space undisturbed in its journey of a thousand years, it may be so treated in its passage through our atmosphere that an image of it cannot be formed in the focus of a telescope, considered as absolutely perfect. An increase of magnifying power would only increase the indistinctness produced by the atmosphere. In the case of a single star thus acted upon, it would be invisible from the diffusion of its light, while in the case of clusters, the cluster would continue to appear a nebula, the diffused light of each star being mingled with that of its neighbours.

The interesting discovery made by Lord Rosse of what is called *spiral nebulæ*, where the nebulous matter may be considered as having been thrown off by some singular cause from the centre of the nebula, has been regarded as hostile to the opinion that such nebulæ are composed of separate stars. An appearance which *might* be caused by motion, is certainly no ground for believing that motion caused it. Various forms have been observed in nebulæ. They are globular and oval, with all degrees of ellipticity, from a circle to a straight line; and Sir

John Herschel remarks it as "a fact, connected in some very intimate manner with the dynamical condition of their subsistence," that they are more difficult of resolution than globular nebulæ. Now these linear nebulæ, which Sir John Herschel thinks are flat ellipsoids seen edgewise, though they may, by speculators in star-dust, be regarded as spheres thrown into their ellipsoidal state by a very rapid rotation round their lesser axis, yet they have no such origin, because they have been resolved into stars. In like manner the nebulæ called *annular*, which have the form of rings, might be regarded by the same theorists as produced from a still more rapid rotation, which we know from the beautiful experiments of M. Plateau, will convert a sphere into a ring; but that this is not their origin is proved by their consisting of stars. The beautiful nebula, for example, between β and γ *Lyræ*, has the appearance of "a flat oval solid ring." "The axes of the ellipse," according to Sir John Herschel, "are to each other in the proportion of about 4 to 5, and the opening occupies about half, or rather more than half the diameter. The central vacuity is not quite dark, but is filled in with faint nebulæ like a gauze stretched over a hoop. The principal telescopes of Lord Rosse resolve this object into

excessively minute stars, and shew filaments of stars adhering to its edges." When this nebula was unresolved, and had the character of a ring nebula, which might be produced by the rapid motion of a nebular sphere round its axis, the star-dust philosopher would have considered its form as a proof that it could not consist of stars; but now that it has been resolved, we are entitled to conclude that in nebulæ, such as the spiral ones, where there is the appearance of motion, the spirals are not purely nebulous matter thrown off from the nucleus like water twirled from a mop, or by any spiral movement whatever.

As the appearance of motion, therefore, in particular nebulæ, is no proof that they consist of purely nebulous matter composed of invisible particles, we are entitled to draw the conclusion that this large class of celestial bodies are clusters of stars at an immense distance from our own system—that each of the stars of which they are composed is the sun or centre of a system of planets, and that these planets are inhabited, or if we follow a strict analogy, that at least *one planet* in each of these numberless systems is, like our earth, the seat of vegetable, animal, and intellectual life.

But independently of these considerations, we are entitled to ask if these nebulæ are *really globular*

and *elliptical*, and their lines of light *really spiral*. We assume that it is *possible*, nay, *highly probable* that they are not. We are all familiar with the deceptive forms assumed by ill-defined and faintly illumined surfaces, and with the disappearance or variation of such forms when we approach the object or see it better. The globular nebulæ of Sir W. Herschel have disappeared as globes under the sharp vision of Lord Rosse's telescope, and the hypothesis, founded upon them, of star-dust condensing into suns has been exploded. The Dumb-bell nebula, too, of Sir John Herschel, has assumed a new shape when examined by Lord Rosse, and every cluster of stars and nebulæ in the heavens, and every form which they now present to the astronomer, either in their outline or on their surface, will, we doubt not, in another age, undergo the most complete metamorphosis. In like manner may not the telescopes of the next century discover appendages to these spirals in certain nebulæ, or so resolve them into stars that their spiral forms will disappear, and the wild speculations which they have suggested be treated with the contempt and ridicule which they merit. An hypothesis founded upon forms that are themselves hypothetical, cannot fail to bring astronomy into contempt.

Before we quit the subject of nebulæ, and purely

nebulous matter, we must notice two points connected with the optical appearance of nebulæ, which we think are strong arguments in favour of their being resolvable into stars. If a nebula consisted of phosphorescent or self-luminous atoms of nebulous matter its light would be immensely inferior in brightness to that of the same nebula composed of suns which are provided with a luminous atmosphere for the very purpose of discharging a brilliant light. When we see, therefore, two nebulæ of the very same brightness, and find by the telescope that one of them only is resolvable into stars, we can scarcely doubt that the other is similarly composed. We cannot conceive that a nebula of phosphorescent atoms could be visible at such enormous distances from our system. When a planetary nebula is equally bright in every part of its disc, like that which is a little to the south of *β Ursæ Majoris*, and which resembles a *flat disc*, "presented to us in a plane precisely perpendicular to the visual ray," it is impossible to regard it as nebulous matter in a state of aggregation. In like manner, all those nebulæ, which have strange and irregular shapes, indicate the absence of any force of aggregation, and authorize us to regard them as clusters of stars.

CHAPTER XII.

GENERAL SUMMARY.

THE arguments for a plurality of worlds, contained in the preceding chapters, are so various, and have such different degrees of force, that different views of the subject will be taken by many who thoroughly believe in the general doctrine. We can easily understand why some persons may believe that all these planets which have satellites are inhabited, while they deny the inhabitability of those that have none, and also of the Sun and the satellites themselves. There are individuals, too, though we doubt their faith in sidereal astronomy, who readily believe that the whole of our planetary system is the seat of life, while they are startled by the statement that every star in the heavens, and every point in a nebula which the most powerful telescope has not separated from its neighbour, is a sun surrounded by inhabited planets like our own; and that immortal beings are swarming through universal

space more numerous than drops of water in the ocean, or the grains of sand upon its shores. But if these persons really believe in the distances and magnitudes of the stars, and of the laws which govern the binary systems of double stars, they must find it equally, if not more difficult to comprehend why innumerable suns and worlds fill the immensity of the universe, revolving round one another, and discharging their light and heat into space, without a plant to spring under their influence, without an animal to rejoice in their genial beams, and without the eye of reason to lift itself devoutly to its Creator. In peopling such worlds with life and intelligence, we *assign the cause of their existence;* and when the mind is once alive to this great truth, it cannot fail to realize the grand combination of *infinity of life with infinity of matter.*

In support of these views, we have already alluded to the almost incredible fact, that there are in our own globe hills and strata miles in length, composed of the fossil remains of microscopic insects; and we need scarcely remind the least informed of our readers, that the air which they breathe, the water which they drink, the food which they eat, the earth on which they tread, the ocean which encircles them, and the atmosphere above their heads, are swarming

with universal life. Wherever we have seen matter we have seen life. Life was not made for matter, but matter for life; and in whatever spot we see its atoms, whether at our feet, or in the planets, or in the remotest star, we may be sure that life is there —life to enjoy the light and heat of God's bounty, to study His works, to recognise His glory, and to bless His name.

Those ungenial minds, or "Low Souls," as the poet calls them, that can be brought to believe that the Earth is the only inhabited body in the universe, will have no difficulty in conceiving that it also might have been without inhabitants. Nay, if such minds are imbued with geological inferences, they must admit that for myriads of years the Earth was without inhabitants; and hence we are led to the extraordinary result, that *for myriads of years there was not an intelligent creature in the vast dominions of the universal King; and that before the formation of the protozoic strata, there was neither a plant nor an animal throughout the infinity of space!* During this long period of universal death, when nature herself was asleep, the Sun with his magnificent attendants, the planets with their faithful satellites, the stars in the binary systems, the Solar system itself, were performing their daily, their annual, and their secular

movements, unseen, unheeded, and fulfilling no purpose that human reason can conceive,—lamps lighting nothing,—fires heating nothing,—waters quenching nothing,—clouds screening nothing,—breezes fanning nothing,—and everything around, mountain and valley, hill and dale, earth and ocean, all *meaning nothing*.

. . . . . The Stars
Did wander darkling in the eternal space.

To our apprehension, such a condition of the Earth, of the Solar system, and of the sidereal universe, would be the same as that of our own globe, if all its vessels of war and of commerce were traversing its seas with empty cabins and freightless holds,—as if all the railways on its surface were in full activity without passengers and goods,—all our machinery beating the air, and gnashing their iron teeth without work performed. A house without tenants, a city without citizens, present to our minds the same idea as a planet without life, and a universe without inhabitants. Why the house was built, why the city was founded, why the planet was made, and why the universe was created, it would be difficult even to conjecture. Equally great would be the difficulty were the planets shapeless lumps of matter poised in ether, and still and motionless as

the grave: but when we consider them as chiselled spheres teeming with inorganic beauty, and in full mechanical activity, performing their appointed motions with such miraculous precision, that their days and their years never err a second of time in hundreds of centuries, the difficulty of believing them to be without life is, if possible, immeasurably increased. To conceive any one material globe, whether a gigantic clod slumbering in space, or a noble planet equipped like our own, and duly performing its appointed task, to have no living occupants, or not in a state of preparation to receive them, seems to us one of those notions which could be harboured only in an ill-educated and ill-regulated mind, a mind without faith and without hope: but to conceive a whole universe of moving and revolving worlds in such a catagory, indicates, in our apprehension, a mind dead to feeling, and under the influence of that intellectual pride which the poet so justly denounces,—

> Ask for what end the heavenly bodies shine,
> Earth for whose use? *Pride* answers, "'Tis for mine:
> Seas roll to waft me, Suns to light me rise,—
> My footstool Earth,—my canopy the skies." [1]—POPE.

[1] Dr. Warton remarks on this passage, that it is the highest absurdity to think that the heavenly bodies were lighted up principally for our use.

But we have been mistaken in thinking that the universe was dead: It was but unborn, the perfect chrysalis from which the living butterfly was to spring. Protozoic forms arose at the Divine command,—the infant plant, the simple mollusc, the noble fish, the still nobler quadruped, successively appeared, and Man, the image of his Maker, and the work of His hand, was invested with the sovereignty of the globe. The Earth, therefore, was made for man, matter for life; and wherever another earth is seen, we are forced to the conviction that it too was made like ours for the use of an intellectual and immortal race.

Although we have repeatedly alluded, in the preceding pages, to the absurdity of supposing suns and planets to be made without any conceivable object, yet the argument may be presented in a more general form. In all the works which are the result of human skill, the great object is to obtain a given effect by the smallest expenditure of labour and of materials. The genius of the artist is less strikingly shewn in producing a new effect, than in producing one well known, with economy of time, of work, and of material. Everything that is not necessary to the final effect of a process, or of a machine, is labour in vain,—a species of work in

which man never willingly indulges. Even where labour is not hallowed by the sweat of the brow,—where it does not earn bread, or is not exhausted in the great structures of civilisation, it is never *labour in vain.* Every act of the mind, and every motion of the hand which it guides, is a step in the great march of social progress, however frivolous its work may seem, and however useless its immediate result. The toy for the child, the telescope for the sage, the locomotive for the railway, the steam-ship for the ocean, are equally, though in different degrees, the result of useful occupation. In the world of instinct there is the same economy of skill and labour,—the spider and the bee, the ant and the beaver, are spendthrifts neither of time nor of toil; and in all the works of the Divine artist around us,—in all the laws of matter and of motion,—in the frame of man and of animals, of plants and of inorganic nature, the economy of power is universally displayed. *Nothing is made in vain,—nothing by a complex process which can be made by a simple one;* and it has often been remarked by the most diligent students of the living world, that the infinite wisdom of the Creator is more strikingly displayed in the economy than in the manifestation of power.

With such truths before us, is it possible to

believe that, with the exception of our little planet, all the other planets of the system, all the hundreds of comets, all the systems of the universe, *are to our reason made in vain?* It is doubtless possible that the Almighty Architect of the universe may have had other objects in view, incomprehensible by us, than that of supporting animal and vegetable life in these magnificent spheres; but as the question we are discussing is one in which we can appeal only to human reason, and as human reason in its highest form cannot discover these other objects, we the inhabitants of one of the least of these spheres, which has for immeasurable periods of time been preparing for the residence of man, must believe, under the guidance of that reason, that they were destined *certainly*, like our Earth, for an intellectual race, and destined *probably* for a previous and lengthened occupation by plants and animals, in order that their inhabitants may study on the tombstones of the past those miraculous processes of growth and decay, of destruction and renovation, by which there has been provided for them so noble an inheritance.

In his celebrated sermon *On the Origin and Frame of the World*, to which we have already referred, Dr. Bentley has taken a view of this part of the

question which, though slightly different from ours, leads him to the same conclusion. Considering "that the soul of one virtuous and religious man is of greater worth and excellency than the Sun and his planets, and all the stars in the world," Dr. Bentley expresses his willingness to believe, that "their usefulness to man might be the sole end of their creation, if it could be proved that they were as beneficial to us as the Polar Star was formerly for navigation, or as the Moon is for producing the tides, and lighting us in winter nights." "But," he adds, "we dare not undertake to show what advantage is brought to us by those innumerable stars in the Galaxy and other parts of the firmament, not discernible by naked eyes, and yet each many thousand times bigger than the whole body of the Earth. If you say, they beget in us a great idea and veneration of the mighty Author and Governor of such stupendous bodies, and excite and elevate our minds to His adoration and praise; you say very truly and well. But would it not raise in us a higher apprehension of the infinite majesty and boundless beneficence of God, to suppose that these remote and vast bodies were formed not merely upon our account to be peeped at through an optic glass, but for different

ends and nobler purposes? And yet who will deny but there are great multitudes of lucid stars even beyond the reach of the best telescopes; and that every visible star may have *opaque planets*[1] revolving about them which we cannot discover? Now, if they were not created for our sakes, it is certain and evident that they were not made for their own; for matter has no life nor perception, is not conscious of its own existence, nor capable of happiness, nor gives the sacrifice of praise and worship to the Author of its being. It remains, therefore, that all bodies were formed for the sake of intelligent minds: and as the Earth was principally designed for the being and service and contemplation of men; why may not all other planets be created for the like uses, each for its own inhabitants which have life and understanding?"[2]

[1] This is the earliest allusion we remember to *dark* bodies in the sidereal regions, unless Dr. Bentley uses the word *opaque* in contradistinction to *self-luminous* bodies. The planets in single or binary systems are invisible from their distance, not from their being unable to reflect light. Mr. Pigot had long ago concluded, from various celestial phenomena, that there are "primary invisible bodies or unenlightened stars that have ever remained in eternal darkness." The late Professor Bessel having found that the proper motions of *Sirius* and *Procyon* deviate very sensibly from uniformity, has come to the conclusion, that they describe orbits in space under the influence of central forces round *dark* or *non-luminous* central bodies, not very remote from the stars themselves.

[2] Eighth Sermon, pp. 5, 6.

Various attempts have been made, but without much success, to give a popular illustration of the argument from analogy, by which we infer the existence of inhabitants in the planets, from their similarity to the Earth. M. Fontenelle, the first person who attempted this, has given the following illustration of it:—"Suppose," says he, "that there never had been any communication between Paris and St. Denis, and that a person who had never been out of the city was upon the towers of Notre Dame, and saw St. Denis at a distance: He is asked if he believes that St. Denis is inhabited, like Paris. He will boldly answer, No. For he will say, I see distinctly the inhabitants of Paris; but those of St. Denis I do not see; and I never heard anybody speak of them. It is true, some will tell him, that from the towers of Notre Dame he cannot see the inhabitants of St. Denis on account of the distance;—that all that he can see of St. Denis greatly resembles Paris;—that St. Denis has steeples, houses, and walls, and that it may very well resemble Paris in being inhabited. All this will produce no effect upon my Parisian; he will persist in maintaining that St. Denis is not inhabited, as he sees nobody. Our St. Denis is the Moon, and each of us is this citizen of Paris, who was never out of

it. You are too severe, said the Marchioness; we are not such fools as your citizen; for, as he sees that St. Denis is just like Paris, he must have lost his reason, if he does not believe that it is inhabited; but the Moon is not at all made like the Earth. Take care, madam, I replied; for if the Moon in every respect resembles the Earth, you will be obliged to admit that the Moon is inhabited."[1]

This illustration is certainly defective; for, as Fontenelle subsequently remarks, the Moon does not so much resemble the earth as St. Denis does Paris. The mistake which the author commits arises from his not comparing the Earth with a planet, like Jupiter having satellites, and clouds, and trade winds, and a diurnal motion. In this case, the citizen should have been a villager looking at Paris from the steeple of St. Denis, and his answer should have been, I think it very probable that there are or have been inhabitants in Paris, but it is possible that they may have all left it, or have not yet arrived. It is just possible, too, that these walls may never have been a protection to inhabitants, nor these churches thronged, nor these houses occupied; but if this were the case, the sovereign who founded the city, who encircled it with a wall

[1] *Œuvres de Fontenelle*, 2de Series, vol. ii. p. 49, edit. 1758.

who erected the churches, and who built the houses, must have been a fool or a madman.

A very different illustration is given by Huygens: "If any person," says he, "were shewn, in the body of a dissected dog, the heart, the stomach, the lungs, the intestines, and then the veins, the arteries, and the nerves, then, though he never saw the open body of an animal, he could hardly doubt that the same structure and variety of parts existed in the ox, the sow, and other quadrupeds. In like manner, if we knew the nature of one of the satellites of Jupiter and Saturn, would we not believe that the very same things which were found in it would be found in all the other satellites? And, if we saw anything in one comet, we would conclude that this was the structure of all. There is therefore much weight in conclusions drawn from analogies, and in inferences from things that are seen to things that are not seen."[1]

The author of the Essay against a Plurality of Worlds, considers the illustration of Fontenelle as unfair; and he gives the following modification of it as representing his own argument more fairly:—

"Let it be supposed," he says, "that we inhabit

[1] *Cosmotheoros*, &c., lib. i. Hugenii *Opera*, tom. ii. pp. 652, 653.

an island, from which innumerable other islands are visible, but the art of navigation being quite unknown, we are ignorant whether any of them are inhabited. In some of these islands are seen masses more or less resembling churches, and some of our neighbours assert that these are churches; that churches must be surrounded by houses, and that houses must have inhabitants; others hold that the seeming churches are only peculiar forms of rocks: in this state of the debate everything depends upon the degree of resemblance to churches which the forms exhibit. But suppose that telescopes are invented and employed with diligence on the questionable shapes. In a long course of careful and skilful examination, no house is seen, and the rocks do not at all become more like churches, rather the contrary. So far, it would seem, the probability of inhabitants in the islands is lessened. But there are other reasons brought into view. Our island is a long extinct volcano, with a tranquil and fertile soil, but the other islands are apparently somewhat different. Some of them are active volcanoes, the volcanic operations covering, so far as we can discern, the whole island: others undergo changes, such as weather or earthquakes may produce; but in none of them can we discover such changes as

shew the hand of man. For these islands, it would seem, the probability of inhabitants is further lessened.[1] And so long as we have no better evidence than these for forming a judgment, it would surely be accounted rash to assert that the islands in general are inhabited; and unreasonable to blame those who deny or doubt it. Nor would such blame be justified by adducing theological or *a priori* arguments; as that the analogy of islands with islands makes the assumption allowable; or that it is inconsistent with the plan of the Creator of islands to leave them uninhabited. For we know that many islands are or were long uninhabited. And if ours were an island occupied by a numerous, well-governed, moral, and religious race, of which the history was known, and of which the relation to the Creator was connected with its history; the assumption of a history, more or less similar to ours, for the inhabitants of the other islands, whose existence was utterly unproved, would, probably, be generally deemed a fitter field for the romance writer than for the philosopher. It could not, at best, rise above the region of vague conjecture."[2]

[1] The observation of volcanoes and church-like rocks, by the telescope, has no parallel in the analogy of the planets. It is not the moon that our author is dealing with, but innumerable planets.

[2] *Of the Plurality of Worlds.* An Essay, pp. 157-159.

This illustration is, we think, so unfair, and so constructed to answer the author's purpose, that we concur in his opinion that the probability of the islands being inhabited "does not rise above the region of vague conjecture." No illustration indeed can be fair or effective, unless it relates to *separate* and *independent* works of God, from the condition of one of which we draw inferences by analogy relative to the state of others of which we know nothing, excepting their points of similitude. In the illustration of Huygens, for example, the dog, the ox, and the sow, are independent existences, of whose internal structure we know nothing; but having found certain organs upon dissecting the dog, we infer the existence of the same organs in the ox, from the external similitude in their general form, and in various external parts. In the parallel between islands and planets, the peopled islands should have been invested with certain properties or conditions necessary for its inhabitants, which should have been possessed by the other islands. The inhabited island, too, should have been made as small in reference to the rest as the Earth is to Jupiter and Saturn. But independent of these defects in the illustration, the mind of the reader is otherwise prepared to admit that they may have no

inhabitants, because we know of hundreds of islands without inhabitants. We can assign also a very good reason why they were made, and why they are not inhabited, and if we were to be assured of the fact, it would excite no surprise whatever. We could not say that God therefore made them in vain, because when the art of navigation is discovered, they may be found to contain gold and silver, coal and iron, and excellent harbours, such as exist in our inhabited island. We, the islanders, may suppose also, that the islands either have been or will be inhabited, and we are entitled to make this supposition, because we must have been originally created upon our own island, and not brought to it by the art of navigation; and consequently, the same creation of inhabitants may have taken place, or may yet take place, in the uninhabited ones. It is obvious, from these remarks, that the previous knowledge of the reader, to whom the appeal is made, influences what he conceives would be the speculation of the islander; and the confusion of ideas which thus takes place, renders the illustration illusory.

The best illustration which we can conceive, is to suppose a philosopher contemplating from a distance the bodies of the Solar system, and wholly

ignorant of their condition. He examines them so as to acquire all the knowledge which we possess of their size—their motions—the influences they receive from the sun, and all the phenomena disclosed by the telescope. He knows nothing about their being inhabited or uninhabited, but being permitted to visit the Earth, he finds it inhabited, and observes the relation which exists between vegetable, animal, and intellectual life,—the influences which emanate from the sun and moon, and the days and nights, and seasons and atmospheric changes which characterize our globe. He then takes his place in the distance, and pondering over all the bodies of the system, he will doubtless conclude that they are all inhabited like the Earth. Had he first visited Jupiter, with its gorgeous magnitude and numerous satellites, and found it inhabited, he might have conceived it *possible* that as the monarch of the system, it might alone have enjoyed the dignity of being the seat of life; but even in this case, the force of analogy would have compelled him to view the Solar system as one great material scheme planned by its Creator, as the residence of moral and intellectual life.

CHAPTER XIII.

REPLY TO OBJECTIONS DRAWN FROM GEOLOGY

IN the preceding chapters we have submitted to the reader the facts and arguments by which the doctrine of a plurality of worlds may be maintained, and we have, at the same time, endeavoured to answer a variety of objections of a moral and scientific nature, which naturally presented themselves in discussions involving so many considerations. We have now, however, a more arduous duty to perform. The author of the Essay to which we have frequently had occasion to refer, has devoted a whole volume to an elaborate attack upon the doctrine we have been supporting. With acquirements of the highest order, and talents of no common kind, which, we think, might have been more usefully employed, he has marshalled all the truths and theories of geology, and all the facts of astronomy, against popular and deeply cherished

opinions,—opinions which the humblest Christian has shared with the most distinguished philosophers and divines, and which no interests, moral or religious, require us to surrender. In questions of doubtful speculation with which vulgar error is largely mingled, we applaud the writer who boldly girds himself for the task of exposing presumption and ignorance, however generally they may prevail; but in the case with which we are dealing, where the opinions assailed are far more probable than the theories and subtleties by which they are to be superseded; where they are entrenched in sound analogies and embalmed in the warmth of the affections, and hallowed by immortal names, we can ascribe to no better feeling than a love of notoriety any attempt to ridicule or unsettle them.

The first and the most plausible of the arguments maintained by the Essayist is drawn from geological facts and theories. We have already, in a preceding chapter, explained these facts, and admitted, with certain limitations, (which, to give our opponent every advantage, we at present abandon,) that during a long period of time when the Earth was preparing for the residence of man, it was the seat only of vegetable and animal life.

Since the Earth, then, was during a very long

time (a *million*[1] of years we shall say) uninhabited by intelligent beings, our author draws the conclusion that all the *other planets may be occupied at present with a life no higher than that of the brutes, or with no life at all;* that is, that there is no plurality of worlds inhabited by rational beings. Now this is not the conclusion which the premises authorize. If God took a million of years to prepare the Earth for man, the probability is, that all the planets were similarly prepared for inhabitants, and that they are *now* occupied by rational beings. If one or more of them are only in the act of being prepared, and are not yet the seat of intelligence, analogy forces us to the conclusion, that they are now occupied by the lower animals, and that they will in due time be inhabited like the Earth by rational beings. The assertion that they may be occupied by *no life at all*, is contrary to analogy, unless we suppose that all the planets are only in that stage of preparation which preceded the *protozoic* age,—a supposition which no person is entitled to make, which the Essayist himself does not make, but which, if it were true, would prove that the time is approach-

[1] We use this number merely to avoid circumlocution. The Essayist uses the word *myriads of generations*, and *myriads of years*, as the period of only one of the earliest formations!

ing when all the planets are to pass through the same stages of revolution to which the Earth has been subjected.

According to the *Nebular hypothesis* adopted by our author, the exterior planets, *Neptune*, *Uranus*, *Saturn*, *Jupiter*, and *Mars*, with all the *thirty Asteroids*, were thrown off in rings from the Solar atmosphere of fire-mist, and condensed into planets *long before the Earth* was thus formed; and as the operation of planet-making, to use a phrase of his own, was begun upon all the more important planets long before ours had emerged from chaos, all these worlds must have been ready for the reception of inhabitants before our race occupied the Earth. Analogy, therefore, authorizes us to conclude not that they *may be*, but that *they are* inhabited.

It is admitted by every geologist that the Earth was not only made to be a fit residence for the human family, but that it was made in such a manner that man might see the wonderful processes by which it was prepared, and read its vast chronology in the history of its fossil remains. Is it not probable, therefore, that the other planets were formed in a similar manner, and with a similar object? And if analogy leads us to believe that all

the planets have been or are in the *azoic*, or *protozoic*, or *palæozoic*, or *neozoic* stage of formation, the conclusion is inevitable, that they are occupied by beings formed after God's image; and consequently, that there is a plurality of worlds. We may put the argument in a simpler form. In the time of Huygens and Fontenelle and Bentley, when the Mosaic account of the creation was adopted in its literal meaning, the argument from analogy had a certain degree of force. Has that degree of force been diminished by the subsequent discovery or supposition that a million of years, in place of six days, were occupied in the preparation of the Earth? The argument from analogy is not only not affected by this discovery, but the discovery itself furnishes us with the new ground of analogy, that planets are made for the very purpose of being inhabited,—that they are made in such a way as to teach their inhabitants the wonderful processes by which the Almighty has made them,—and that they are made of materials essentially necessary for man's personal and social happiness. Man was not made for the planet—but the planet was made for man.

Quitting the ground of analogy, our author has recourse to what we consider the most shallow piece of sophistry which we have ever encountered

in modern dialectics. He founds an elaborate argument on the mutual relation of an *atom of time* and an *atom of space*, comparing the different periods of time occupied in the formation of the Earth with the different distances of the systems in space. In this process, he divides the great geological period into *four* periods of *time*, and the infinity of space into *four* lengths of space; and he "assumes that the numbers which express the antiquity of the four periods" are "on the same scale as the numbers which express the *four* magnitudes," or lengths of space. We have placed these periods in contrast in the following table, to exhibit clearly the nature of the argument:—

TIME.	SPACE.
1. "The *Present* organic condition of the Earth."	1. "The magnitude of the *Earth*."
2. "The *Tertiary* period of geologists which preceded that."	2. "The magnitude of the Solar system compared with the Earth."
3. "The *Secondary* period which was anterior to that."	3. "The distance of the nearest *fixed stars* compared with the *Solar system*."
4. "The *Primary* period which preceded the Secondary."	4. "The distance of the *most remote nebulæ* compared with the *nearest fixed star*."

In this table of *Time* and *Space*, the time during which the Earth has been in its present condition,

which is nearly 6,000 years, is contrasted with the magnitude of the Earth, which is 7,926 miles in diameter, and these numbers are units in the scale, the one being called an *atom of time* compared with the duration of the primary geological period, and the other an *atom of space* compared with the distance of the remotest nebulæ. Now the importance, or the *significance* of the Earth, in regard to space, is fairly measured by its diameter of 7,926 miles, which is a fixed quantity; but its significance with regard to time is not measured by 6,000 years, because its duration is constantly increasing, and every year adds to its *significance;* that is, the *atom of time* is approximating to infinity, while the atom of space is invariable. Admitting, however, our author's premises, let us consider his extraordinary conclusions:—

"We find," says he, "*that man* (the human race from its present origin till now) *has occupied but an atom of time*, as he *has occupied but an atom of space.*" And again,—

"The scale of man's *insignificance* is of the same order in reference to *time* as to *space*. . . . . If the Earth as the habitation of man is a *speck* in the midst of an infinity of space, the Earth as the habitation of man is also a *speck* at the end of an

infinity of time. If we are as *nothing* in the surrounding universe, we are as *nothing* in the elapsed eternity; or rather in the elapsed organic antiquity during which the Earth has existed, and been the abode of life. . . . . Or is the objection this? That if we suppose the Earth only to be occupied with inhabitants, all the other objects of the universe are *wasted*, turned to no purpose? Is *work* of this kind unsuited to the character of the Creator? But here, again, *we have the like waste* in the occupation of the Earth. *All its previous ages have been wasted upon mere brute life;* often, so far as we can see, for myriads of years, upon the lowest, the least conscious forms of life, upon shell-fish, corals, sponges. Why, then, should not the seas and continents of other planets *be occupied at present with a life no higher than this*, OR WITH NO LIFE AT ALL? . . . . The intelligent part of creation is *thrust* into the *compass of a few years* in the course of myriads of ages; why, then, not into the *compass of a few miles* in the expanse of systems? . . . . If then the Earth be the sole inhabited spot in the work of creation, the oasis in the desert of our system, there is nothing in this contrary to the analogy of creation."

That is, *The Earth, the* ATOM OF SPACE, *is the only*

one of the planetary and sidereal worlds that is inhabited, because it was so long without inhabitants, and has been occupied only an ATOM OF TIME! If any of our readers see the force of this argument, they must possess an acuteness of perception to which we lay no claim. To us it is not only illogical;—it is a mere sound in the ear, without any sense in the brain. What relation is there between *the* SHORT *period of man's occupation of the Earth*, and *the* SMALL *portion which he occupies in space?* If there is such a relation, that we can reason from the truth of the *first* to the probability of the *second*, then we can reason as justly from the truth of the *second* to the probability of the *first*. Now, let us suppose it to be as certain that the Earth is the only inhabited planet, as it is certain that Man has occupied the Earth only for the short period of 6,000 years, could any rational being allege that because man occupied only an atom of space, he therefore must live only an atom of time upon the Earth?

But even if we admit the result with regard to Man, the argument does not apply to other intellectual beings than Man—to an inferior or to a superior race that never occupied the Earth at all. If man is thus limited by a syllogism to the occupation of one planet, one atom of space,—an angelic race, who

never lived on the Earth at all, may be indulged with the occupation of Jupiter. But, farther, let us suppose that we learn by the telescope that every planet and satellite in the Solar system is inhabited by *Man*, he would still occupy but an *atom of space*, and our author's argument would go to prove that none of the fixed stars or binary systems are inhabited. In like manner, if we could prove that the binary systems were inhabited, the sum of them all would be but an atom of space, and our author would still rejoice in his conclusion, that the clusters of stars and nebulæ were uninhabited vapour.

If the reasoning which we have examined be sound in its nature, which it is not, it would fail entirely by a change in the premises. If it is *probable*, as we have already shewn it is, that the time of the Earth's preparation was comparatively short—If it be *possible*, which we aver it is, that intelligent beings occupied the Earth previous to man; and if it is *probable* that Man will continue to occupy the Earth during a period equal, or approximating to the period of the Earth's preparation, the whole of our author's argument has neither force nor meaning.

But even if the Almighty has spent a million of years in preparing the crust of the Earth as a

suitable residence for man, by the slow operation of secondary causes, and has deposited the remains of vegetable and animal life in each member of its formation, in order to enable man to read the history of His omnipotence and wisdom, is that any reason why the Earth, the residence of man, should, among countless and more glorious worlds than his own, be *the only one that is inhabited?* Reason and common sense dictate a very different opinion. If *nearly infinity of time* has been employed to provide for intellectual and immortal life so glorious an abode, is it not probable that *nearly infinity* of space will be devoted to the same noble purpose?

But without availing ourselves of any of these defects in our author's argument, we may safely meet him on his own ground, and try the question by the ordeal of his own principles. We admit, then, to the fullest extent, that enormous periods of time were necessary, by the operation of physical causes, to prepare the Earth for the human family—not only for the past generations of men, but for all future generations, and possibly for higher orders of intelligence that may succeed them. But the enormous duration of past time, which geological phenomena require, rests on the hypothesis that these phenomena are due to physical causes

similar in their nature to those which are now in operation. If we believe, then, that all past changes in the Earth have been the result of secondary causes, we cannot possibly deny the probability that future changes will be effected by the same causes. Now, admitting this hypothesis as applicable to the future, the long duration of past time in the Earth's history is not more certain than the enormous duration of that period during which our Earth, under the action of existing agencies, must continue as it is, adapted for the residence of such beings as man. Unless, therefore, we suppose that rational beings are to disappear from the Earth, while it remains fitted to be their home, it is manifest that the *long past*, void of intelligent beings, and the *long future* of such beings of some order or other, as inhabitants of the Earth, must rest on the same hypothesis,—*the invariability of the nature of physical causes*. Any argument, therefore, founded on the *absolute* length of the former of these periods, and not on its *relative* length when compared with the latter, must be fallacious. At the present time the period of the Earth's occupation by man has been short, but every century adds to its length, and neither reason nor Scripture leads us to believe that the Solar system will ever be destroyed, or that

rational beings will ever cease to occupy the Earth. The age of the inhabited Earth is, therefore, continually approximating to that of the ancient Earth, and after becoming equal to it, will probably become greater, and approximate to infinity. In this way the scale of time in the geological argument of the Essayist is inverted. The atom of time has, in his language, become infinity, while the scale of space continues permanent as before. If this is not the case, we are involved in the inconceivable absurdity that the Architect of the universe took millions of years to make a world which was to be occupied only for a few thousands. To spend a thousand years in building and furnishing a house which was to be occupied only for one year, would be a supposition too ridiculous to be introduced into a volume of romance.

CHAPTER XIV.

OBJECTIONS FROM THE NATURE OF NEBULÆ.

IN a preceding chapter on nebulæ, we trust we have satisfied the candid inquirer that all nebulæ are clusters of stars, and that there is no proof whatever, not even its shadow, that in the sidereal regions there is what is called nebulous matter, either existing in a stationary condition, or aggregating into stars. The author of the Essay *Of the Plurality of Worlds*, whose astronomical objections to the doctrine of a plurality of worlds we are about to consider, very dexterously commences his argument with an attack upon that part of the doctrine which relates to nebulæ. He is not content with a statement of facts, but he attempts to throw ridicule upon his opponents by the application of words which are calculated to influence the minds of ignorant or inattentive readers. By calling nebulæ *clouds*, and pieces of *comets' tails*, and the stars into which they are resolved, *shining dots*,

pieces of bright *curd*, luminous *grains*, and *lumps of light*, he fancies that he has demolished the opinion of astronomers that these *dots* are suns; that they are "as far from each other as the dog-star" is from us; that each sun has its system of planets, and each planet its animal and vegetable life.

"An astronomer," says the Essayist, "armed with a powerful telescope, *resolves* a nebula, discerns that a luminous cloud is composed of shining dots: —but what are these dots? Into what does he resolve the nebula? Into *stars*, it is commonly said. Let us not wrangle about words. By all means let these dots be stars, if we know about what we are speaking,—if a *star* merely means a luminous dot in the sky. But that these stars shall resemble in their nature stars of the first magnitude, and that such stars shall resemble our sun, are surely very bold structures of assumption to build on such a basis. Some nebulæ are resolvable—are resolvable into distinct points—certainly a very curious, probably a very important discovery. We may hereafter learn, that *all* nebulæ are resolvable into distinct points; that would be a still more curious discovery. But what would it amount to? What would be the simple way of expressing it without hypothesis and without assumption? Plainly this,—that the

substance of all nebulæ is not continuous but discrete;—separable and separate into distinct luminous elements; nebulæ are, it would thus seem, as it were, of a *curdled* or *granulated* texture; they have run into *lumps of light*, or have been formed originally of such lumps. Highly curious! But what are these lumps? How large are they? At what distances? Of what structure? Of what use? It would seem that he must be a bold man who undertakes to answer these questions. Certainly he must appear to *ordinary thinkers* to be *very* bold, who, in reply, says gravely and confidently, as if he had authority for his teaching, These lumps, O man, are suns; they are distant from each other as far as the dog-star is from us; each has its system of planets, which revolve around it; and each of these planets is the seat of animal and vegetable creation. Among these planets some, we do not yet know how many, are occupied by rational and responsible creatures like man; and the only matter which perplexes us, holding this belief on astronomical grounds, is, that we do not quite see how to put our theology into its due place and form in our system."[1]

This, surely, is neither the language nor the tone

[1] *Essay*, &c. pp. 120-122.

of a man of science in search of truth, or holding in respect the great revelations of astronomy. The Essayist triumphantly asks *four* questions, and tells us that he would be a *bold* man that undertakes to answer them. We accept the challenge, and appeal to our readers.

Question 1. *How large are the lumps of light*, or the shining dots, into which the astronomer's powerful telescope has resolved the nebulæ? These lumps of light are admitted to be *stars* shining by their own light. Now, it has been shewn by the most distinguished astronomers, by Herschel and by Struve, that in the various orders of distances in space, the distances of the nebulæ are the greatest. According to the recent researches of Mr. Peters, as given by M. Struve,[1] the following are the distances of the stars of different magnitudes, as ascertained by a process approximately correct:—

Apparent Magnitudes.	Parallaxes.	Distances in radii of Earth's orbit.
1, . .	0″·209	98600
2, . .	0″·116	1778000
3, . .	0″·076	2725000
4, . .	0″·054	3850000
5, . .	0″·037	5378000
6, . .	0″·027	7616000
8½, . .	0″·008	24490000
11½, . .	0″·00092	224500000

[1] *Etudes d'Astronomie Stellaire.*

As the nebulæ are obviously more remote than any of the stars in the preceding table, and as the nearest of these stars must, from their distance, be equal to our sun, we are entitled to conclude, that the stars in nebulæ must be of a much greater size. Sir John Herschel observes, that "when we consider that the united lustre of a group or *globular* cluster of stars, affects the eye with a less impression of light than a star of the *fourth* magnitude, (for the largest of these clusters is scarcely visible to the naked eye,) the idea *we are thus compelled to form* of their distance from us may prepare us *for almost any estimate of their dimensions.*" A visible *dot*, or a visible *lump*, must therefore be a body of enormous magnitude, and though we cannot give its exact size in miles or diameters of the Earth, we are sure that every astronomer in the old or the new world will allow that we have answered the question with sufficient accuracy in reference to the object for which it was asked. *The size of the* DOT *or lump is of sufficient magnitude to be a sun.*

Quest. 2. *At what distances* are the dots or lumps from one another?

In order to answer this question, the Essayist knows well that we require to have the apparent distance between the centres of the *dots*, and upon

the supposition that the two dots are at the same distance from us, we can easily determine their distance from the parallax which may be assumed for resolvable nebulæ. In the binary systems there are two stars, whose apparent distance is as small as that of the *dots* or stars in the nebulæ, and yet every astronomer admits that there is ample room for a system of planets to circulate round and between them.

Quest. 3. *What is the structure* of these dots or stars? The author certainly does not expect to learn whether the stars are made of *granite* or *grey-wacke.* Analogy teaches us that their structure will be similar to that of the only sun with which we are acquainted. It will consist of a luminous envelope enclosing a dark nucleus.

Quest. 4. *What is the use of the dots or stars?* Being large bodies, and self-luminous, they can be of no conceivable use but to give light to planets, or to the solid nuclei of which they consist.

Having thus given answers to our author's questions,—answers which we are confident would be given by every astronomer, may we not ask in return, What is the *size*, and *distance*, and *structure*, and *use* of the dots upon his hypothesis, that they are patches of comets' tails or luminous *grains?*

The Essayist is silent. Should he be the *very bold man* to make the attempt, the astronomical world would repudiate his theory and his answers.

But there is another way of meeting objections of such an unreasonable character. Our author is a firm believer in the geological speculation, that the Earth required "*myriads of millions*" of years for its formation, and assuming his principle of contrasting time and space, may we not ask him in return, What was the structure of the primitive Earth? What were the periods of time required for the deposition of each formation? And of what use was an arrangement requiring *myriads of millions of years* for its completion?

Believing that "nebulæ are vast masses of incoherent, or gaseous matter, of immense tenuity, and destitute of solid moving bodies," a theory which he derives from another theory called the *nebular hypothesis*, without adducing the least trace of evidence in its support, our author boasts, not surely in the spirit of the inductive philosophy, that *he seems to have made it* CERTAIN that the *celestial objects* (the nebulæ) *are not inhabited.* To this we reply, that we have made it MORE PROBABLE that the CELESTIAL *objects are inhabited,*—an assertion less presumptuous, but more certain than his.

We have described in a preceding chapter the *spiral nebulæ* discovered by Lord Rosse, and we have endeavoured to explain the appearance of motion, which may be considered as indicated by the spirals which they exhibit. With his accustomed boldness, and extravagance of speculation, our Essayist has made the following observations on these spiral forms:—"The comet of Encke," he affirms, "describes a spiral gradually converging to the Sun," and "in 30,000 years this comet *will* complete its spiral, and be absorbed in the central mass. . . . . But this spiral converging to its pole so slowly, that it reaches it only after forming 10,000 circuits (or spirals,") while "there are at most three or more circular or oval sweeps in each spiral (of the nebulæ,) or even the spiral reaches the centre before it has completed a single revolution round it." From data like these, the following theory of the spiral nebulæ is deduced:—"If we suppose the comet (that of Encke) to consist of a luminous mass, *or a string of masses*, which would occupy a considerable arch of such an orbit, the orbit would be marked by a track of light as an oval spiral, or if such a comet were to separate into two portions, as *we have, with our own eyes, recently seen Biela's Comet do*, or into a greater number; then

these portions would be distributed along such a spiral. And if we suppose a large mass of cometic matter thus to move in a highly resisting medium, and to consist of patches of different densities, then some would move faster, and some more slowly, but all in spirals, such as have been spoken of, and the general aspect produced would be that of the *Spiral Nebulæ*, which I have endeavoured to describe." A hypothesis more wild and gratuitous than this was never before submitted to the scientific world. In what part of the nebula do the cometic patches reside before they begin their motion of descent to the nucleus; and what is the cause of their quitting their place of rest? No comet out of the many hundreds that have been observed, has been so negligent of its tail as to leave it behind. Encke's Comet has been equally careful of its appendage, and the division of Biela's Comet was only *apparent*. But even if a comet were to separate into a number of portions, these portions would, like the half of Biela's Comet, travel along with it and again unite themselves into one, so that the analogy of this comet is destructive of the speculation which it is brought to support.

CHAPTER XV.

OBJECTIONS FROM THE NATURE OF THE FIXED STARS AND BINARY SYSTEMS.

HAVING, as our author congratulates himself, "cleared away the supposed inhabitants from the outskirts of creation, so far as the nebulæ are the outskirts of creation," he proceeds to consider the fixed stars, and examine any evidence which he may be able to discover as to the probability of their containing in themselves, or in their accompanying bodies, as planets, inhabitants of any kind. We have already stated the grounds upon which the most distinguished astronomers have believed that single and double stars are accompanied with planets similar to our own; and we shall now consider the objections which are made to this opinion.

Beginning with *clusters of stars*, the author whose opinions we have been controverting, justly observes, that they are in the same category with resolvable

nebulæ, and he therefore regards it as "a very bold assumption to assume, without any further proof, that these *bright points* are suns, distant from each other as far as we are from the nearest stars." When these *clusters* are *globular*, Sir John Herschel regards their form as "indicating the existence of some general bond of union in the nature of an attractive force;" and assuming that the "globular space may be filled with equal stars, uniformly dispersed through it, and very numerous, each of them attracting every other with a force inversely as the square of the distance, . . . each star would describe a perfect ellipse about the common centre of gravity as its centre," Sir John therefore conceives that "such a system might subsist, and realize in a great measure that abstract and ideal harmony which Newton has shewn to characterize a law of force directly as the distance."

Referring to this ingenious theory of globular clusters, the Essayist illustrates it by asserting, that if "our Sun were broken into fragments, so as to fill the sphere girdled by the Earth's orbit, all the fragments would revolve round the centre in a year," and as there is no symptom in any cluster of its parts moving so fast, he concludes that clusters, like nebulæ, must be extremely rare, that is,

vaporous, like the tails of comets. In support of this view of the subject, he alleges that the boldness of the opposite opinion, that they are suns, *appears to be felt* by our wisest astronomer, meaning Sir John Herschel, to whom he refers in such a manner as if Sir John maintained the same opinion with himself. This, however, is far from being the case, as his own words will prove: "*Perhaps*," says he, "it may be thought to savour of the gigantesque to look upon the individuals of such a group as suns like our own, and their mutual distances as equal to those which separate our sun from the nearest fixed star: *yet*, when we consider that their united lustre affects the eye with a less impression of light than a star of the fourth magnitude, the idea *we are thus compelled* to form of their distance from us may prepare us for almost any estimate of their dimensions."[1]

The same just views of the sidereal system, in which no motion is visible, are taken by Dr. Whewell, in his Bridgewater Treatise.[2] "Astronomy," says he, "teaches us that the stars which we see have no immediate relation to our system. The *obvious supposition* is, that they are of the natur-

[1] *Outlines, &c.*, § 866, referred to by the Essayist.
[2] Book III. chap. ii. p. 270.

and order of our sun: the minuteness of their apparent magnitude agrees, on this supposition, with *the enormous and almost inconceivable* distance which, from all the measurements of astronomers, we are led to attribute to them. *If, then, these are suns, they may, like our sun, have planets revolving round them,* and *these* may, like our planet, be *the seats of vegetable, animal, and rational life*:—we may thus have in the universe worlds, no one knows how many, no one can guess how varied; but, however many, however varied, they are still but so many provinces in the same empire, subject to common rules, governed by a common power."

From the globular clusters of stars our author proceeds to the binary systems, of which we have treated in a preceding chapter. He admits that the law of universal gravitation is established for several of these systems, "with as complete evidence as that which carries its operation to the orbits of Uranus and Neptune," but he endeavours to shew that each of the stars of the best known binary systems, *α Centauri* and 61 *Cygni*, "*may have its luminous matter diffused through a globe as large as the Earth's annual orbit*," and that, in this case, "it would not *be more* dense than the tail of a comet." It is in vain to argue against assertions like these,

which can only be met by an equally positive denial of them. In the present case, however, we can do more. Sir John Herschel has shewn that the sum of the two masses of the double star 61 *Cygni*, is to that of the Sun as 0·353 to 1, or nearly as 1 to 3·1, and hence he concludes, that "the Sun is neither vastly greater nor vastly less than the stars composing 61 *Cygni*." The conclusion, therefore, of the Essayist, that the matter of these systems, "of these brilliant constituents," as Sir John Herschel calls them, would fill the Earth's orbit, and have the rarity of comets' tails, is contrary to astronomical truth.

We have already seen that Sir John Herschel considers these double stars as suns, "accompanied with their trains of planets and satellites," and has stated the conditions necessary for the *existence of their inhabitants*. To our Essayist such a scheme appears so *complex*, that it would be "impossible to arrange it in a stable manner," so as to protect the inhabitants from *such dangers*, and he considers himself as having overturned Sir John Herschel's view, by simply asserting, without a ground even for the assertion, that "their sun may be a vast sphere of luminous matter, and the planets, plunged into this atmosphere, may, instead of describing

regular orbits, plough their way in spiral paths through the nebulous abyss to its central nucleus"!

Having obtained, as our author sarcastically remarks, "but little promise of inhabitants from clustered stars and double stars," he turns his attention to the *single stars* as the most hopeful cases, and asks, "what is the probability that the fixed stars or some of them really have planets revolving round them?" To this he justly replies, that "the only proof that the fixed stars are the centres of planetary systems, resides in the assumption that these stars are *like the sun*;—resemble him in their qualities and nature, and therefore must have the same offices and the same appendages."

In admitting that the stars, like the sun, shine with an independent light, our author attempts to reduce the force of this point of resemblance by asserting, that "they resemble not only the sun, but nebulous patches in the sky, and the tails of comets," and that "there is no obvious distinction between the original light of the stars and the reflected light of the planets." Now these statements are either irrelevant or erroneous. The nebulous patches are clusters of stars. It is not true that comets' tails are self-luminous, and it is utterly untrue that star light and planet light are

the same. Our author ought to have known that the reflected light of the planets contains precisely the same definite dark lines in their spectra as the light of the sun, which it ought to do, as it is the same light; while it has been proved by the direct observations of Fraunhofer and others, that the light of *Sirius*, *Procyon*, and other stars, is essentially different, having definite dark lines which do not exist in the light of the sun.

His next assertion is, that though the mass of certain stars is one-third of that of the sun, yet their matter *may be* diffused through a sphere equal to the earth's annual orbit, and that this may be the matrix, so to speak, both of the sun and planets of a system not yet formed—thus taking for granted the truth of the nebular hypothesis, adopted by the author of the *Vestiges of Creation*, and maintained only by persons who have very erroneous ideas of creation. The worlds were not made by the operation of law, but by the immediate agency of the Almighty. Sir Isaac Newton considered the nebular theory as tending to Atheism, and in his five interesting letters to Dr. Bentley, he has ably controverted it. "The growth of new systems," he says, "out of old ones, (the doctrine maintained by the Essayist,) without the mediation of a Divine power, seems to me appa-

rently absurd." "The diurnal rotation of the planets could not be derived from gravity, *but required a Divine* arm to impress them." "The same power," says Newton, "whether natural or supernatural, which placed the sun in the centre of the six primary planets, placed *Saturn* in the centre of the orbs of his five secondary planets; and *Jupiter* in the centre of his four secondary planets; and the *Earth* in the centre of the moon's orbit; and therefore had this cause been a blind one, *without contrivance or design*, the sun would have been a body of the same kind with *Saturn*, *Jupiter*, and the *Earth*; that is, *without* light or heat. Why there is one body in our system qualified to give light and heat to all the rest, I know no reason, but because the Author of the system thought it convenient: and why there is but one body of this kind, I know no reason, but because one was sufficient to warm and enlighten all the rest."[1]

That the stars undergo changes in their mechanical condition, the Essayist considers to be proved by observation. One of these proofs is the different colours of different stars, a fact certainly, but in no respects a proof of change. Had their *colours*

[1] *Newtoni Opera*, tom. iv. p. 430, &c.

changed,[1] we might have inferred a change of condition; but knowing that no such change takes place, our author most presumptuously regards "their different colours as arising from their being at different stages of their progress," an opinion without a shadow of probability either from observation or analogy. His next proof of change is derived from the "mighty changes of which we have evidence in the view which geology gives us of the history of this Earth;" but this is no proof at all. The changes there referred to are mere changes in the crust of the Earth, and not in its mechanical condition, and changes, too, which would not show themselves even to the moon by any change of colour or of aspect. "*If*, therefore," the Essayist continues, "*stellar globes can become planetary systems* in the progress of ages, it will not be at all inconsistent with what we know of the *order of nature*, that only a few, or even that only *one*, (our Earth he means,) should have yet reached that condition. *All the others* but the *one* (our Earth) may be systems yet unformed, (or *fragments* or *sparks* as he subse-

[1] Ptolemy is said to have noted Sirius as a *red* star, though it is now white. Sirius twinkles with *red* and *blue* light, and Ptolemy's eyes, like those of several other persons, may have been more sensitive to the *red* than to the *blue* rays.

quently calls them,) *struck off in the forming of the one!*" To such a succession of assertions and hypotheses it is scarcely necessary to reply. Stellar globes have never become planetary systems; and nature has no such order. We are thus thrown back to the astronomy of Julius Cæsar:

> "The skies are *painted* with unnumbered *sparks*."
> SHAKESPEARE.

The next argument adduced by our author, that the stars are unlike our sun, is the existence of changes in the stars supposed to be indicated by the disappearance of some stars, the appearance of others, and the variations in the light of a considerable number. The disappearance of a star *proves* only that it has turned a dark side to our system, and the appearance of a new star, that its luminous side has come round to us in the course of its rotation; while the variations in the light of others may arise from spots upon their surface, from eclipses by their planets, or from obscuration by comets' tails, when the variations are of an irregular character. From all these causes our own sun may be a variable star to other planets. To us even its light is diminished when large spots come across its disc, and when we consider the great number of comets

which belong to our system, and the immense magnitude of their tails, the sun's light must be occasionally obscured by the interposition of these imperfectly transparent bodies.

That the Fixed Stars are *like* our sun in every point in which it is possible to compare them, will not now be doubted we think by our readers. That they are suns themselves, as Copernicus, Galileo, Kepler, Newton, Huygens,[1] and Laplace, and almost every astronomer believes, and as all analogy proves, is a doctrine which, we trust, will equally command their faith.

In concluding his chapter on the Fixed Stars, our Essayist utters sentiments, and throws out conjectures so insulting to Astronomy, and casting such ridicule even on the subject of his own work, that we can ascribe them only to some morbid condition of the mental powers, which feeds upon paradox, and delights in doing violence to sentiments deeply cherished, and to opinions universally believed. We almost doubt the accuracy of our vision, when we read the conjecture that the glorious stars which compose the sidereal universe,—that "Arcturus,

[1] "I cannot doubt," says Huygens, "along *with the greatest philosophers of the age*, that the Fixed Stars are of the same nature with the Sun."—*Cosmotheoros*, lib. ii. p. 705.

Orion, and the Pleiades," which Scripture tells us "God made," were never created by Him at all, and "are really long since extinct!" He had previously stated, "that in consequence of the time employed in the transmission of visual impressions, our seeing a star is evidence not that it exists now, but that it existed it may be many thousands of years ago;" and thinking that such a statement might seem to some readers to throw doubts upon reasonings which he had employed, he makes the following extraordinary observation :—"It may be said that a star which was a *mere chaos* when the light by which we see it set out from it, may, in the thousands of years which have since elapsed, *have grown into an orderly world.* To which *bare possibility* we may oppose another supposition, *at least equally possible*, that *the distant stars were sparks or fragments struck off in the formation of the Solar system, which are* REALLY *long since extinct, and survive in appearance only by the light which they at first emitted.*"[1]

Now, these *two* suppositions which our author makes *at least equally possible*, stand in a very different relation to each other. The *first* supposition, that

[1] *Sidereal Astronomy*, the most exalted branch of human knowledge, is thus reduced to the *study of sparks* struck off in the formation of planets!

a *world in a state of chaos* may have grown into *an orderly world*, has a *high degree of probability* from the fact, which both Scripture and geology teach us, that our own Earth passed from a state of chaos into an orderly world; while the *second* supposition, *that the distant stars are sparks struck off in the formation of the Solar system*, is not only utterly false, but *absolutely impossible*,—impossible, too, on the *nebular hypothesis* to which the author has set his seal, and impossible on the wildest hypotheses of creation which have ever issued from the disordered brain of humanity. If a spark did escape from the grasp of the mighty Artist when He meted out the planets with His measure, and gathered their waters in the hollow of His hand, it could only have been a spark or a puff of that mud and steam out of which our author has modelled the exterior planets, and which, if steam, must soon have expanded into its elements before it reached the place of even the nearest star in the heavens, or formed the *hundred million of stars* which roll in the immensity of space.

After such a speculation as this, bordering, as we think, on the blasphemous, and in palpable contradiction of the demonstrated truths of sidereal astronomy, we need hardly put the question with which we intended to conclude this chapter. If

the *stars* are not *suns*, for what conceivable purpose were they created? Our author has answered the question by asserting, that they were never created at all! To such philosophy and theology we prefer that of the poet,—

> "Each of these stars is a religious house;
> I saw their altars smoke, their incense rise,
> And heard hosannahs ring through every sphere.
> The great Proprietor's all-bounteous hand
> Leaves nothing waste, but sows these fiery fields
> With seeds of reason, which to virtues rise
> Beneath his genial ray."
>
> YOUNG.

CHAPTER XVI.

OBJECTIONS FROM THE NATURE OF THE PLANETS.

HAVING sullied the glories of the sidereal world by converting the stars and systems which compose it, into vapour, gas, and comets' tails, the Essayist proceeds to apply the same process to the planets of the Solar system, converting those exterior to the Earth into "immense clouds with continuous water collected at their centre, and the interior ones into *cinder* or *sheets of rigid slag like the moon!* while the satellites of Jupiter and Saturn are characterized as "vapour wandering loose about their atmospheres, and *neatly wound into balls!*"

This process commences with *Neptune*, whose vast globe he describes as "only a huge *mass of cloud and vapour, water and air*," and as *a dark and cold world*, where the light and heat of the Sun is incapable of "unfolding the vital powers, and cherishing the vital enjoyments of animals;"—an

assumption without any evidence to support it. It is true, that if we consider the solar influences as emanations following a geometrical law, their power upon the surface of Neptune must be greatly enfeebled; but such a law does not exist. Although the Sun is nearest the Earth in winter, his heat and light are, from different causes, much reduced; and we know, as we have shewn in a former chapter, that there may be conditions of the *atmosphere* of the remoter planets which may procure for them a more genial influence from the Sun, or there may be temperatures in their interior which may supply the place of it by heat radiated from their surface.

In the very middle of summer we have cold days and nights, with crystals of ice floating in the atmosphere, and exhibiting their existence by the production of halos round the Sun and Moon; and in the very middle of winter, when the Sun is about to return from the southern tropic, we have frequently temperatures not very different from those of summer. With regard to the Sun's light on Neptune and the remoter planets, we have already mentioned that with a more sensitive retina, the inhabitants could see as distinctly as ourselves. In proof of this we may adduce the fact mentioned by Boyle, of

a person having such a tenderness of retina, that he could, in a dark night, see and distinguish plainly colours of ribands and other objects which had been placed on the inside of his curtains, when he was asleep. The same sensibility of the nerves of the ear was shewn in another case, where the person could hear at a distance the softest whispers which no other person could at all perceive.[1]

In thus "beginning with the outermost of the planets at present known, namely, Neptune," the Essayist exhibits the same ingenuity which he displayed in commencing with the Nebulæ. In dealing with Neptune his argument rests solely on the darkness and coldness which is supposed to unfit the planet for being the residence of life. He takes no notice of the fact relied upon by his opponents, that Neptune has certainly *one* and probably *two or more Satellites*, but starts into a new maze of sophistry, by appealing to the Moon! Under the pretence of learning if there is "any *general* ground for assuming inhabitants in Neptune," he tells us that, "the chance of learning this, is to endeavour to ascertain the fact in the body which is nearest to us," namely, the Moon; and being quite confident

[1] Of the Determinate Nature of Effluviums, p. 26, quoted in a MS. of Sir Isaac Newton's.

that he is to prove the Moon to be unfit for inhabitants, he gives us warning of a formidable attack upon our position by announcing, that if the Earth be inhabited, and the Moon not, *we have then no right to assume at once, that any other body in the Solar system belongs to the former of these classes rather than to the latter.* A position so illogical and untenable, no philosopher, in search of truth, durst here venture to take. Had the Moon been the primary planet nearest to the Earth, the assertion would have been just, but if it were revealed to us, that the Moon had no inhabitants, it would not diminish, in the slightest degree, the probability of Jupiter's being inhabited. We have already seen that the Moon has great functions to perform, as the satellite of the Earth, even if no living thing breathed upon her surface; but no person has ventured to assign any function to Jupiter, if he does not resemble the Earth in being the seat of life.

In proceeding to unpeople the Moon, the Essayist tells us, that "careful and skilful astronomers, who have examined the Moon's surface, have, all of them, without exception, been led to the belief that the Moon is not inhabited—but waste and barren, like streams of lava, or the sands of Africa. To this

statement we have only to reply, that it is not true. Huygens and Sir W. Herschel, Dr. Olbers, and many others, have declared their belief that there are inhabitants in the Moon, and we believe, that all astronomers would come to the same conclusion were they satisfied that the Moon had an atmosphere. This incorrect assertion on the part of the Essayist is followed by other two assertions equally unfounded—that there is no water in the Moon, and "no atmosphere and vapour, or air," and that no changes have been observed upon her surface. We have already proved, that there must be an atmosphere in the Moon, and the existence of active volcanoes places it beyond a doubt, that there must have been changes upon her surface.

The same observations which apply to Neptune are applicable to *Uranus*, *Saturn*, and *Jupiter*,—the same objections on the part of the Essayist, and the same reply to them. Jupiter, however, is the planet to which he especially calls our attention; and after much irrelevant speculation respecting the internal condition of our globe, as produced by the superincumbent weight of its outer formations, and "allowing for the compression of the interior parts of Jupiter," he pronounces it "tolerably certain that his density is not greater than it would be if

his entire globe were composed of water," and he concludes that Jupiter must therefore be *a mere sphere of water*. He afterwards states there is "much evidence against the existence of solid land" in that planet; but in opposition to this evidence, he subsequently contributes *a few cinders at the centre*,—articles, doubtless, of peculiar value and interest, where everything else is water. The existence of *cinders*, however, where there is *no heat*, and where, as we shall presently see, the water is *ice*, must have perplexed his chemistry, and hence he wisely withdraws them, by telling us that the waters in Jupiter are *bottomless*, that is, *without a nucleus of cinders*.

In order to prove that *Jupiter* and the exterior planets cannot be inhabited, he adduces the *extreme* cold which is supposed to exist upon their surface; but when his assertion that Jupiter is a *sphere of water*, and if peopled at all, peopled with *cartilaginous* and *glutinous monsters*, *boneless*, *watery*, *pulpy creatures*, *imperfect and embryotic lumps of vitality*, floating in the fluid, is met with the objection that *the waters must be frozen*, he has no difficulty in making Jupiter as *hot* to answer this one purpose as he formerly made it *cold* to answer another. In this wonderful process of *adaptation*, our author's genius

and his inductive methods are singularly displayed. No difficulty is to him unsurmountable. In his omniscience of speculation he finds a theory for anything or everything; "Even in the outer regions of our atmosphere," he says, "the cold is *probably* very many degrees below freezing, and in the blank and airless void beyond, it *may be* colder still. It has been calculated by physical philosophers, on grounds which seem to be solid, that the cold in the space beyond our atmosphere is 100° below Zero. *The space near to Jupiter*, IF AN ABSOLUTE VACUUM, in which there is no *matter to receive and retain heat*, MAY, PERHAPS, BE NO COLDER THAN IT IS NEARER THE SUN!" Were we to indulge in arbitrary conjectures like these, we could refute, without argument, all our author's objections to a plurality of worlds; but without availing ourselves of so destructive a weapon, may we not upon good grounds, prefer the *probable ice* to the *possible water*, and accommodate the inhabitants of Jupiter, like Arctic islanders and Russian princes, with very comfortable quarters in huts of snow and houses of crystal, warmed perchance by subterranean heat, and lighted with the hydrogen of its waters, and its cinders not wholly deprived of their bitumen?

But we are not driven to the necessity of

believing that Jupiter and the exterior planets are either *water* or *ice* That they are neither composed of the one material nor the other, is proved by direct experiment. If their surfaces were either wholly or partly aqueous, the rays reflected from them when the planets are in quadrature, would contain, what it does not, a large portion of polarized light; and if their crust consisted of mountains, and precipices, and rocks of ice, some of whose faces must occasionally reflect the incident light at nearly the polarizing angle, the polarization of their light would be distinctly indicated.

Had our author not exhibited the great amount of his knowledge, we should have charged him with ignorance of the various forms and conditions of matter in which the same elements may be combined, and form bodies of very different densities, but we believe that he knows these as well as we do, and, in our position, would use them more skilfully. It is difficult to understand why Jupiter should be made of water. His density is 1·359, (that of the Earth being 5·66, and that of water being 1·000,) greater even than that of certain specimens of *coal*, far greater than *amianthus*, and *pumice stone*, which are lighter than water. *Silex* or *flint*, too, occurs with such various densities that there are conditions

of it less dense than Jupiter. In the state of *tabasheer* it is very much lighter than water. In the state of *siliceous sinter* its density is only 1·8. In the state of *opal* its density is 1·9, and in certain varieties of *quartz* it is so high as 2·88. There are *pitchstones*, too, varying from 1·9 of specific gravity to 2·70; and there are metals, too, like spongy platina, of small specific gravity, so that the hardest mineral, and the most compact metal, may exist in *Jupiter*, and yet his density not exceed 1·359. But why should the minerals in Jupiter be of the same nature as those on the Earth? May not the elementary atoms of matter be there combined according to different laws, and form *spars*, and *gems*, and *metals*, entirely different from ours? Admitting, however, for a moment, the supposition, otherwise inadmissible, that there is a terrestrial type of inorganic bodies which is to be the exemplar for all the planets, we have only to suppose these planets to be hollow, or to contain large cavities, in order to reconcile their average densities with the densities of terrestrial bodies.

From the watery constitution of Jupiter, the Essayist passes to the force of gravity on his surface, as an argument against the existence of inhabitants. We have already, in a previous chapter,

computed the force of gravity on Jupiter, and shewn that it is only two and a-half times that on our own globe, so that a man weighing ten stone here would weigh only twenty-five on Jupiter, a weight which, with proportionally strong bones and muscles, he could bear, and at the same time work as actively as we do. We have all seen corpulent men, weighing twenty-five stone, such as Daniel Lambert, a man doubtless incapable of the same active exertions as other men; but this arises from his weight not being the result of a due proportion of bone, muscle, and fat, but a mere accumulation of the latter. Let us now see how the Essayist deals with this question. Admitting, as he does, that the force of gravity is the same which we have adopted, he remarks, that a "man transferred to the surface of Jupiter would feel a stave carried in his hands, and would feel his own limbs also, become two and a-half times as heavy as they were before. Under such circumstances animals of large dimensions would be oppressed with their own weight. . . . An elephant could not trot with two or three elephants placed upon his back. A lion or tiger could not spring with twice or thrice his own weight hung about his neck." We request the reader's attention to this disingenuous statement

calculated so expressly to deceive him. Were an elephant sent to Jupiter, two and a-half elephants would certainly not be placed upon his back. His head, his trunk, his tail, his limbs, and his entrails would all be two and a-half times heavier; but this additional weight would not act as if it were placed upon his back. His four limbs would doubtless bear it, but it would not hinder him from trotting, a motion, by the way, which might be dispensed with in an animal which could perform much useful work by doing it more slowly. The lion and the tiger would certainly not spring very nimbly with such a millstone as twice or thrice their weight *hung about their neck*, but when they go to Jupiter, they will not be exposed to such a humiliation. The weight will be diffused over every part of their frame, and we are sure that the author would not place himself within the range of their spring on the faith of his own hypothesis.

It is interesting to mark with what different feelings Sir John Herschel views the various intensities of light and of gravity upon the different planets of our system. After enumerating the proportions of these different powers, he exclaims,—"Now, under the various combinations of elements so important to life as these, what immense diver-

sity must we not admit in the conditions of that great problem, the maintenance of animal and intellectual existence and happiness, which seems, so far as we can judge, by what we see around us in our own planet, and by the way in which every corner of it is crowded with living beings, to form an unceasing and worthy object for the exercise of the Benevolence and Wisdom which preside over all."[1]

The arguments against Saturn being inhabited, our author considers to be much stronger than in the case of Jupiter. He tells us that "the outer part of the globe of Saturn is *proved* to be vapour by his streaks and belts," and that "*we must* either suppose that he has no inhabitants, or that *they are aqueous gelatinous creatures, too sluggish almost to be deemed alive*, floating in their ice-cold water, and shrouded for ever by their humid skies!" He "cannot tell us," he says, "whether they have eyes or no, but *probably*, if they had, they would never see the sun; and therefore," he continues, "we need not *commisserate their lot* in not seeing the host of Saturnian satellites, and the ring which to an intelligent Saturnian spectator would be so splendid a celestial object. The ring is a glorious object for

[1] *Outlines of Astronomy*, § 508.

man's view and his contemplation, and therefore *is not* altogether without its use. Still less need we (as some[1] appear to do) regard as a *serious misfortune* to the inhabitants of certain regions of the planet, a solar eclipse of fifteen years' duration, to which they are liable by the interposition of the ring between them and the sun." This specimen of our author's dialectics, in which a large dose of banter and ridicule is seasoned with a little condiment of science, forms a painful contrast with the following noble passage, in which Sir John Herschel discusses the very same subject. "The rings of Saturn must present a magnificent spectacle from those regions of the planets which lie above their enlightened sides, as vast arches spanning the sky from horizon to horizon, and holding an almost invariable situation among the stars. On the other hand, in the regions beneath the dark side, a solar eclipse of fifteen years in duration, under their shadow, must afford (to our ideas) an inhospitable asylum to animated beings, ill compensated by the faint light of the satellites. *But we shall do wrong* to judge of the fitness or unfitness of their con-

[1] The author here refers to Sir John Herschel, whose authority he quotes for the Solar eclipse of fifteen years.—*Outlines, &c.*, § 522.

dition from what we see around us, when perhaps the very combinations which only convey images of horror to our minds, *may be, in reality, theatres of the most striking and glorious displays of beneficent contrivance.*"

The remarkable phenomenon, however, of a *fifteen* years' eclipse of the Sun to the regions of Saturn, placed under the shadow of the dark side of the ring, does not exist, and is therefore not a *serious misfortune* to the inhabitants of those regions. Dr. Lardner, in an elaborate memoir, "On the Appearance of Saturn's Rings to the Inhabitants of the Planets,[1]" has solved the problem of the appearance of the system of rings in the Saturnian firmament, and described their effect in eclipsing occasionally and temporarily the sun, the eight moons, and other celestial objects.

"It is there demonstrated," he says, "that the infinite skill of the great Architect of the universe has not permitted that this stupendous annular appendage, the uses of which still remain undiscovered, should be the cause of such darkness and desolation to the inhabitants of the planet, and such an aggravation of the rigours of their fifteen years' winter, as it has been inferred to be. . . . . It

[1] *Transactions of the Astronomical Society*, 1853, vol. xxii.

is shewn, on the contrary, that by the apparent motion of the heavens, produced by the diurnal rotation of Saturn, the celestial objects, including, of course, the sun and the eight moons, are not carried parallel to the edges of the rings, as has been hitherto supposed; that they are moved so as to pass alternately from side to side of each of these edges; that, in general, such objects as pass under the rings are only occulted by them for short intervals, before and after their meridional culmination; that though under some rare and exceptional circumstances and conditions, certain objects, the sun being among the number, are occulted from rising to setting, the continuance of such phenomena is not such as has been supposed, and the places of its occurrence are far more limited. In short, *it has no such character as would deprive the planet of any essential condition of habitability.*"

By arguments "of the same kind, as in the case of Jupiter and Saturn, but greatly increased in strength," as he alleges, our Essayist banishes inhabitants from *Neptune* and *Uranus*, and he sneeringly "commends the supposition of the probable watery nature and low vitality of their inhabitants to the consideration of those who contend for inhabitants in those remote regions of the Solar system."

In returning towards the sun, our author pays his passing respects to *Mars*, which he thinks is more likely to have inhabitants than any other planet. This probability, however, disappears, and he concedes to this planet the possibility of having "creatures of the nature of corals and molluscs, saurians and iguanodons."

The thirty asteroids between Mars and Jupiter afford our author a new and inviting field for speculation. He considers them as *mere dots*, whose form is not even known to be spherical. Setting aside the theory that they are the fragments of an exploded planet, he thinks "they may be the results of some *imperfectly effected* concentration of the elements of our system, (of fire-mist or star-dust,) which if it had gone on more completely and regularly, might have produced another planet between Mars and Jupiter. Perhaps they are only the larger masses among a great number of smaller ones, resulting from such a process: and it is very conceivable that the meteoric stones, which have from time to time fallen upon the Earth's surface, are other results of the like process;—bits of planets *which have failed in the making, and lost their way* till arrested by the resistance of the Earth's atmosphere!"

In order to explain how there is such "an immense number of small bodies" in the Solar system, he begins by enumerating them in the following manner,—"First, Mars, who is only about one-eighth of the earth in mass: the thirty small planetoids between Mars and Jupiter, the five satellites of Jupiter, the eight satellites of Saturn, the six satellites of Uranus, and the one satellite of Neptune." Having thus found *fifty* small bodies, he states it to be very remarkable that "*all this array begins to be found* outside *of the Earth's orbit*," and he immediately provides a theory of their formation, having apparently forgotten that nineteen of them are formed, according to the nebular theorists, as satellites round their primaries in the same manner, and for the same purpose, as the Moon was formed from the Earth's atmosphere. "That none but masses of this size," says he, "are found outside of Mars, appears to indicate, that the *planet-making* powers which were efficacious to this distance from the Sun, and which produced the great globe of the Earth, were, beyond this point, *feebler*, so that *they could only give birth to smaller masses, to planetoids, to satellites, and to meteoric stones.* Perhaps we may describe this want of energy in the planet-making power, by saying, that

at so great a distance from the central fire there was *not heat enough to melt together these smaller fragments* into a larger globe; or rather, when they existed in a nebular, perhaps in a gaseous state, that there was not enough heat to keep them in that state till the attraction of the parts of all of them had drawn them into one mass, which might afterwards solidify into a single globe. In this singular passage it is declared, that the power of making planets transposed by the Creator to material laws existing on the Sun's atmosphere of fire-mist, is not sufficient for its purpose. The power has failed, and the work, consequently, has been bungled. The central fire was not hot enough, and the article was underdone. In explanation of this failure, our author tells us in a note, that it is "in our own day a great achievement of man to direct the fiery influences which he can command, so as to cast a colossal statue in a single piece, instead of casting it in several portions;" that is, man has achieved this difficult task, but God, or His agency, has failed in it, that is, "in melting into a larger globe" the fifty small fragments of satellites and asteroids, and the thousand and one meteoric stones which, owing to the want of a good fire, are showered down on the earth occasionally and

periodically for no other purpose than to kill cattle and puzzle philosophers. In this explanation, the *fifty* small bodies and the thousand and one meteoric stones, are considered as *solid fragments*, whereas we are told in the preceding page that all the *nineteen satellites are pieces of vapour neatly wound into balls!*

As the Essayist is not only a believer, but an improver of the *nebular* hypothesis, his explanation of the fifty fragments ought to have had, upon his own principles, a more scientific form. After the Earth, with its moon, was thrown off from the Sun's atmosphere in a ring or belt, and subsequently solidified, the central fire had not sufficient heat to make a larger planet than Mars. At the next planetary station the fire was still more defective, and could not produce a planet at all. Now, we ask how it happened that at the next station, when the heat must have been enormously diminished, it had power to produce so gigantic a planet as Jupiter? And we ask again how Jupiter himself, whose heat must have been excessive, was not able to melt and consolidate into one, or to retain as a part of himself, his four satellites. It is needless to extend the same questions to Saturn, Uranus, and Neptune, where the central heat was so very

evanescent, as our author makes it, and which are all huge globes of matter compared with the inferior planets.

The two interior planets, *Venus* and *Mercury*, are depopulated in a single page. The light and heat of Venus is admitted to be only "double those which come to the Earth." She may have "a surface like the Moon," or "may have cooled more slowly and quietly, like glass which has been annealed in the fire." He finds it "hard to say what kinds of animals he could place in her, except perhaps the microscopic creatures with siliceous coverings, which, as modern explorers assert, are almost indestructible by heat."—"Of Mercury," he says, "we know still less, and he has not, so far as we can tell, any of the conditions which make animal existence conceivable."

> Seasonless, herbless, treeless, moonless, lifeless.
> A lump of Death—a chaos of hard clay!

Opinions of a very different nature from these, we have already had occasion to state in a preceding chapter, and we must leave it to the judgment of the reader to decide upon their relative probabilities.

In order to combine under one general principle the views which he has taken of the condition of the

individual planets, the Essayist adopts the *nebular hypothesis*, which we have already explained, and upon it he erects a scheme or a theory of the Solar system, which he considers as having a sort of *religious dignity*, though he fears that, at first, it may appear to many, rash, fanciful, and almost irreverent. In this scheme, the *fire* and *water* of the nebular mass have been separated during their "*planet-making powers*," "the water and the vapour which belong to the system being driven off into the outer regions of its vast circuit, while the solid masses, ... such as result from the fusion of the most solid materials, lie nearer the Sun, and are found principally within the orbit of Jupiter." In support of these theories he adduces the zodiacal light, itself a creature of theory, as an appendage to the Sun, and as the remains of the Sun's atmosphere extending beyond the orbits of Mercury and Venus —"planets which are, therefore, within a nebular region, which *may easily be conceived to be uninhabitable.* And where this nebular region, marked by the zodiacal light, terminates, *the world of life begins, namely, at the Earth! The orbit of the Earth is the temperate zone of the Solar system*, and in that zone is the play of Hot and Cold, of Moist and Dry possible."

In concluding this novel and startling theory of the Solar system, the Essayist tells us that "the Earth is placed in that region of the system in which the *planet-forming powers* are the most vigorous and potent, and that *the Earth is really the largest planetary body in the Solar system,—its domestic hearth, and the only world in the universe;*" or, which is the same thing, that there are no real planets in the system but the Earth.

> Thus man exclaims, "See All things for my use!"
> "See man for mine!" replies a pampered goose:
> And just as short of reason he must fall,
> Who thinks All made for One, not One for All.—POPE.

We are unwilling to charge the author of such theories with cherishing opinions hostile to religion. We believe that he is ignorant of their tendency, and that he has forgotten the truths of inspiration, and even those of natural religion, amid the excitement of discussions, from which he is to obtain the high reputation of "having accounted for, and reduced into consistency and connexion, a very extraordinary number of points hitherto unexplained." But, however sincere may be his piety, which we do not question, we tell him, with confidence, that his theories are replete with danger, and that young minds will draw from them opinions the very

reverse of his own. When we are told that a planet has been bungled in its formation, that meteoric stones are bits of planets which have failed in the making,[1] and lost their way, can we believe that the all-wise Creator was present at the process, "making the earth by His power, establishing the world by his wisdom, and stretching out the heaven by his understanding?"[2] Can we believe that He who formed *the worlds* has made only *one*, and that, in place of resting on the seventh day, He rested during the whole week of creation, and still rests, having transferred His almighty power to certain laws of matter and motion, by which the Sun and all his planets were *manufactured* from nebulous matter? Sir Isaac Newton considered the nebular hypothesis, though in his time not known by that name, as not only absurd, but verging on atheism. In reference to the creation of a central and immovable sun, he observes, that to suppose a "central particle so accurately placed in the middle (of nebulous matter in a finite space) as to be

[1] "We know of no blemishes or blunders in creation," says Professor Sedgwick, "and were they there, what would it matter to our conception of them, whether they sprang from dead material laws ordained by an all-powerful and all-seeing God, or from an immediate defect in creative power?"

[2] Jeremiah li. 15.

always equally attracted on all sides, and thereby continue without motion, seems to me fully as hard as to make the sharpest needle stand upright on its point upon a looking-glass. And much harder it is to suppose that all the particles in an infinite space should be so accurately poised, one upon another, as to stand still in a perfect equilibrium. For I reckon this as hard as to make not one needle only, but an infinite number of them, stand accurately poised upon their points."[1] And in another place he urges another objection to the hypothesis: "But how the matter (the nebular matter) should divide itself into two sorts, and that part of it which is fit to compose a shining body should fall down into one mass, and make a sun, and the rest, which is fit to compose an opaque body, should coalesce, not into one great body, like the shining matter, but into many little ones, I do not think explicable by mere natural causes, but am forced to ascribe it to the counsel and contrivance of a voluntary agent."[2] And with respect to the diurnal rotation of the planets, he distinctly declares that "they could not be derived from gravity, but required a divine arm to impress them."[3]

A more modern, and still living author, who, we

[1] *Letters to Bentley*, Lett. iv. [2] *Id.* Lett. i. [3] *Id.* Lett. iv.

trust, will long continue an honour to science and to his country, has characterized speculations like these, as "dashing from hypothesis to hypothesis, and building a scheme of nature against nature, and against the sober interpretation of those who have best studied their works." We will not say of the language of the Essayist, when he speaks of Nature, or the God of Nature, having failed in producing a planet where He intended it to be, and of having recorded that failure by broken planets and showers of meteoric stones;[1]—we will not say what Professor Sedgwick has said of speculations about the nebular hypothesis not more absurd, that they are "the raving madness of hypothetical extravagance;" but we sincerely, and without desiring to give offence, adopt the rest of his declaration, "that it is at open war with all the calm lessons of inductive truth, and, in any interpretation we can give it, bears upon its front the stamp of folly and irreverence towards the God of Nature." Philo-

[1] "The planets and the stars," says the Essayist, "are the lumps which have flown from the Potter's wheel of the Great-worker, the shred coils of which, in His working, sprung from His mighty lathe;—the sparks which darted from his awful anvil, when the Solar system lay incandescent thereon:—the curls of vapour which rose from the great caldron of creation, when its elements were separated" ||—P. 243.

sophers and divines, with humbler minds and loftier aspirations, have bequeathed to us nobler lessons than these which we have been controverting.

After contemplating the wonderful systems of Jupiter and Saturn, with their satellites, Huygens bursts into the following noble expressions of his views :—"Who, upon studying these systems, and comparing them together, can fail to be astonished at the magnitude and noble preparations of these two planets, in comparison with the little and insignificant Earth of ours? or whose mind can now cherish the belief, that in this one planet, among those circling round the Sun, all beauty was to be found, all animals, and all beings that could admire the heavens;—that the great Creator of all had indeed placed nothing upon them, and had created such vast solid structures, that we dwarfs and mortals might look at their light, and, perhaps, study their nature."[1]

The celebrated Emanuel Swedenborg, a name not sufficiently respected, has given utterance to the same sentiments, in language far from visionary. "Any man of an enlarged understanding," he says, "may conclude, from various considerations, that

[1] *Cosmotheoros*, Lib. ii. p. 699.

there is a plurality of Earths, and that they are inhabited by human creatures. It is a suggestion of reason that so great masses of matter as the planets are, some of which far exceed this Earth in magnitude, are not empty balls, created only to revolve round the Sun, and to transmit their scanty measure of light for the benefit of this Earth; but that their use must needs be more enlarged and eminent. He who believes, as every one ought to believe, that the Deity created the universe for no other end, but that the human race, and thereby the heavens might have existence, (for the human race is the seminary of heaven,) must needs believe also, that wheresoever there is an earth, there are human inhabitants." After stating the astronomical facts upon which he has been led to these views, and drawing from them the conclusion that there is a Plurality of systems, with Suns and Planets of their own, he assigns it as the object of so immense a creation, that "the visible universe, or the heaven, resplendent with stars so innumerable, which are so many suns, is only a means for the existence of Earths, and of men upon them, of whom may be formed a heavenly kingdom."[1]

[1] "*Concerning the Earths in our Solar System which are called Planets.*"

In language less animated with religious views, but not less firm and unhesitating, does the illustrious Laplace, the Newton of France, express his belief in a Plurality of Worlds: "Not only," says he, "does the Sun act, by his attraction, upon all these globes, by forcing them to move round himself, but he sheds upon them his light and his heat. This beneficent action gives life to the plants and animals that cover the Earth, and analogy leads us to believe that it produces the same effects upon the planets; for it is not natural to think, that the matter, whose peculiarity we see developed in so many ways, is barren upon such a large planet as Jupiter, which, like our own globe, has its days, its nights, and its years, and upon which observations indicate changes that suppose very active forces. Man, made for the temperature which he enjoys upon the Earth, could not, according to all appearance, live upon the other planets: but ought we not to have there *an infinity of organizations suited to the different temperatures of the globes of the universe?* If the difference merely of elements and of climates produces such a variety in terrestrial productions, how much greater a difference ought there to be in those *of the different planets and their satellites!* The

most active imaginations cannot form any idea of it; but their existence is very probable."[1]

Such are the sentiments of philosophers of all sects, and of divines of all creeds, and we venture to say, that there is no opinion out of the region of pure demonstration, more universally cherished than the doctrine of a Plurality of Worlds. The Astronomer who is guided only by analogies—the Philosopher who has studied the relation between the moral and the material universe—the Naturalist who looks to the other worlds for creations indicated, but not developed, in his own,—the Christian who confides only in what is revealed, and the Poet who transfers to the stars the affections and memories of the past,

[1] *Exposition du Systeme du Monde*, Liv. 5me, chap. vi. Laplace expresses also the opinion, that there is, beyond our system, innumerable suns, which may be the centres of as many planetary systems; and that there exist in the celestial spheres as many dark bodies as there are stars. Without multiplying extracts from the writings of philosophers and divines, it may be sufficient to state, that Dr. Derham, in his *Astro-theology*, 3rd edit., 1717, pp. xlvii, liii, liv, has stated his reasons for believing that the fixed stars and planets "are *worlds*, or places of *habitation*, which is concluded from their being *habitable*, and well provided for *habitation*." Dr. Paley also, though he does not discuss the subject, evinces his opinion when he states, "that even ignorance of the *sensitive* natures *by which other planets are inhabited*, necessarily keeps from us the knowledge of numberless utilities, relations, and subserviences, which we perceive upon our own globe."—*Natural Theology*, edited by Lord Brougham and Sir Charles Bell, London, 1836, p. 16.

have all accepted the grand truth, and rejoiced in the hopes which it inspires.

> The depth of human reason must become
> As deep as is the holy human heart,
> Ere aught in written phrases can impart
> The might and meaning of this ecstasy,
> To those low souls who hold the mystery
> Of the unseen universe for Dark and Dumb.
>
> MONCKTON MILNES.

CHAPTER XVII.

THE FUTURE OF THE UNIVERSE.

HAD the doctrine of a Plurality of Worlds been one of those subjects which merely gratify our curiosity, we should not have occupied the reader's time, or spent our own, in illustrating and defending it. While the scientific truths on which it depends form one of the most interesting branches of natural theology, and yield the most striking proofs of wisdom and design, they are intimately associated with the future destiny of Man.

There are three departments of Natural Theology which demand our most earnest attention,—the living world around us, the world of the past, and the worlds of the future. In the wonderful mechanisms of animal and vegetable life with which we are so familiar, and in the inorganic structures amid which we dwell, we recognise imperfectly the innumerable proofs of matchless skill and benevo-

lent adaptations with which they abound. Our daily familiarity with the ordinary phenomena of life, degrades them in our estimation. There is something which we deem unclean even in the healthy condition of animal bodies, and their functions and their products, which deters all but professional men from their study, and robs them of their inherent claims as proofs of design and as incentives to piety. Even the chemistry of inspiration by which we live, and the science of the Eye and the Ear, those matchless proofs of design, on which all our intercourse with nature and with society depends, are scarcely known to the best educated of the people.

It is otherwise, however, with that department of natural science which treats of the formations and fossil remains of an ancient world. With the structure and functions of animals which inhabited the earth previous to its occupation by man, we have no familiarity. We see them only in their graves of stone, and beneath their monuments of marble—creations which cannot again die, and with which everything mortal has ceased to be associated. Time, in its most hoary aspect, has invested them with a hallowed and a mystic character. The green waves have washed them in their coral beds, and after ages

of ablution in a tempestuous sea, the ordeal of a central fire has completed their purification. The bones, and the integuments, and the meanest products of animal life, have thus become sainted relics which the most sensitive may handle, and the most delicate may prize.

But there is another department of natural science which in its interests is deeper and more varied still. Carrying us back to the birth of matter, before life was breathed among its atoms, and before light rushed through the darkness of space, Astronomy unites, in a remarkable degree, the interests of the past, the present, and the future. From the time when the Earth was without form and void to the present hour, Astronomy has been the study of the shepherd and the sage, and in the bosom of sidereal space the genius of man has explored the most gigantic works of the Almighty, and studied the most mysterious of His arrangements. But while the astronomer ponders over the wonderful structures of the spheres, and investigates the laws of their motions, the Christian contemplates them with a warmer and more affectionate interest. From their past and present history his eager eye turns to the future of the sidereal systems, and he looks to them as the hallowed spots in which his immortal

existence is to run. Scripture has not spoken with an articulate voice of the future locality of the blest, but Reason has combined the scattered utterances of Inspiration, and, with a voice almost oracular, has declared that He who made the worlds, will in the worlds which He has made, place the beings of His choice. In the spiritual character of their faith, the ambassadors of our Saviour have not referred to the materiality of His future kingdom;[1] but Reason compels us to believe, that the material body, which is to be raised, must be subject to material laws, and reside in a material home—in a system of many planets—a house of many mansions, though not made with many hands.

In what regions of space these mansions are built—on what sphere the mouldering dust is to be gathered and revived, and by what process the immortal being is to reach its destination, Reason does not enable us to determine; but it is impossible for intellectual man, with the light of revelation as his guide, to doubt a moment that on the celestial spheres his future is to be spent—spent, doubtless, in lofty inquiries—in social intercourse—in the

[1] Dr. Campbell and other commentators are of opinion that there is nothing allegorical in our Saviour's promise to drink new wine with His disciples in His Father's kingdom. (Matthew xxvi. 29.)

renewal of domestic ties,—and in the service of his almighty Benefactor. With such a vista before us, so wide in its expanse, and so remote in its termination, what scenes of beauty—what forms of the sublime—what enjoyments, physical and intellectual, may we not anticipate,—wisdom to the sage—rest to the pilgrim—and gladness to the broken in heart!

> "How welcome those untrodden spheres!
> How sweet this very hour to die!
> To soar from earth, and find all fears
> Lost in thy light—Eternity.
>
> Oh! in that future let us think
> To hold each heart the heart that shares;
> With them the immortal waters drink,
> And soul in soul grow deathless theirs."—BYRON.

If these expectations be just, how are we to implant them in the popular mind as incentives to piety and principles of action? The future of the Christian is not defined in his creed. Enwrapt in apocalyptic mysteries, it evades his grasp, and presents no salient points upon which either reason or imagination can rest. He looks beyond the grave as into a nebular region, where a few stars are with difficulty descried; but he sees no glorious suns, and no gigantic planets upon which he is to dwell. It is astronomy alone, when its simple truths are impressed upon the mind, that opens to the Chris-

tian's eye the mysterious expanse of the universe; that fills it with objects which arrest his deepest attention; and creates an intelligible paradise in the worlds to come.

To the vulgar eye that sees nothing in the stars but their light, and to the dark mind that has no faith in the verdicts of science, the star-clad firmament presents neither associations in the past nor glories in the future. To them the stars are truly but *specks* or *dots of light*, not more interesting than the firefly in a summer evening, or the ephemeral sparks that fly from the anvil. Their feeble and glimmering ray, dimmed by each rising exhalation, and paling even before the zephyr's breath, has failed to arrest the poet's eye, or gild the painter's canvas. It has never lighted the lover to his mistress, nor the pilgrim to his shrine, nor the hero to his deed of glory. But no sooner does Science with her magic wand marshal the celestial host—planet—satellite and star—into the systems of worlds which roll in the bosom of space, than Faith "takes up the wondrous tale," and associates with these bright abodes the future fortunes of immortal and regenerated man. It places there the loved and the lost—it follows them into the celestial bowers—it joins them in the anthem to "mortal minstrelsy

unknown"—it listens to their warning and their welcoming voice, and round the joyous hearth which it consecrates in the house of many mansions, it assembles hearts once severed and broken, and longs to wander beside the "rivers of the waters of life" with the prophets that expounded it—the sages that enlightened it—the martyrs that suffered for it, and the noble victims that bled in its cause. Imagination takes up the theme where Faith and Reason leave it. The chariots of flame and the horses of fire that bore Elijah from his star of earth, and surrounded Elisha in the mountains of Syria, and the wheels of amber and of fire which were exhibited to the captive prophet on the banks of the Chebar, become, in the poet's eye, the vehicle from planet to planet, and from star to star, in which the heavenly host is to survey the wonders and glories of the Universe.

If the knowledge of the material world—of its facts and of its laws, is thus instructive, and thus inspiring, we must strive to elevate the popular mind by the truths of natural science, teaching them in every school, and recommending, if not illustrating them, from every pulpit. We must instruct our youth, and even age itself, in the geology and physical geography of the Earth, that

they may learn the structure and use of its brother planets; and we must fix in their memories, and associate with their affections, the great truths in the planetary and sidereal universe on which the doctrine of more worlds than one must necessarily rest. Thus familiar with the more magnificent works of creation,—thus seeing them through the heart, as well as through the eye, the young will look to the future with a keener glance, and with brighter hopes;—the weary and the heavy laden,

Lifting their tearful eye unto the stars,

will rejoice in the vision of their place of rest;—the philosopher will scan with a new sense the lofty spheres in which he is to study;—and the Christian will recognise, in the worlds of stars, the gorgeous temples in which he is to offer his sacrifice of praise.

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